DOCUMENT RESUME

ED 422 494 CE 077 017

TITLE	Welding Series. Educational Resources for the Machine Tool Industry. Course Syllabi, Instructor's Handbook, [and] Student Laboratory Manual.
INSTITUTION	Texas State Technical Coll. System, Waco.
SPONS AGENCY	Office of Vocational and Adult Education (ED), Washington, DC.; National Science Foundation, Arlington, VA. Div. of Undergraduate Education.
PUB DATE	1998-00-00
NOTE	3145p.; For related documents, see ED 401 431-445 and CE 077 005-017. Product of the MASTER (Machine Tool Advanced Skills Technology Educational Resources) Consortium.
CONTRACT	DUE-9553716
AVAILABLE FROM	Online at http://machinetool.tstc.edu
PUB TYPE	Guides - Classroom - Learner (051) -- Guides - Classroom - Teacher (052)
EDRS PRICE	MF29/PC126 Plus Postage.
DESCRIPTORS	Behavioral Objectives; Competence; Competency Based Education; Course Descriptions; Curriculum Design; Curriculum Guides; Instructional Materials; *Job Skills; Job Training; Learning Activities; Learning Modules; *Machine Tool Operators; Manufacturing Industry; Postsecondary Education; *Sheet Metal Work; Student Evaluation; Teaching Methods; *Technical Education; Vocational Education; *Welding
IDENTIFIERS	DACUM Process

ABSTRACT

This package consists of course syllabi, an instructor's handbook, and a student laboratory manual for a 2-year vocational training program to prepare students for entry-level employment as welders. The program was developed through a modification of the DACUM (Developing a Curriculum) technique. The course syllabi volume begins with the MASTER (Machine Tool Advanced Skills Technology Educational Resources) Program Consortium competency profile with 25 duties (and supporting technical workplace competencies): follow safety practices; total quality; work ethics; communication skills; work as a team; mathematical skills; weld-related requirements; blueprinting, structural layout and fit-up; set-up welding process(es); prepare joint for welding; oxyacetylene cutting and welding; shield metal arc welding (SMAW)--basic; SMAW--advanced; gas metal arc welding (GMAW)--basic; GMAW short circuit transfer (intermediate); GMAW spray and pulsed spray, pipe transfer (advanced); flux core arc welding (FCAW); gas tungsten arc welding (GTAW)--basic; GTAW--advanced; plasma arc cutting and welding; in-process weld inspection; in-process rework; housekeeping activities; emergency vehicle terminology; and wellness/physical abilities. The first volume contains the justification, documentation, and course syllabi for the courses. Each syllabus contains the following: course description; prerequisites; course objectives; required course materials; methods of instruction; lecture outline; lab outline; Secretary's Commission on Achieving Necessary Skills competencies taught; and appropriate reference materials. The three-volume instructor's handbook consists of technical training modules that include some or all of the following: time required; duty; task; objective(s); instructional materials list; references; student

+++++ ED422494 Has Multi-page SFR---Level=1 +++++

preparation; introduction; presentation outline; practical application; evaluation; summary; and attachments, including handouts, laboratory worksheets, and self-assessment with answer key. The handbook is arranged by duty grouping, with technical modules developed for each task box on the competency profile. The two-volume student laboratory manual contains a DACUM chart and learning modules for duties A-U. Each module in the student manual includes some or all of the following: objectives, outline, laboratory exercises, laboratory aids, and handouts. (KC)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 422 494

Welding Series
Educational Resources for the Machine Tool Industry
Course Syllabi
Instructor's Handbook
Student Laboratory Manual

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

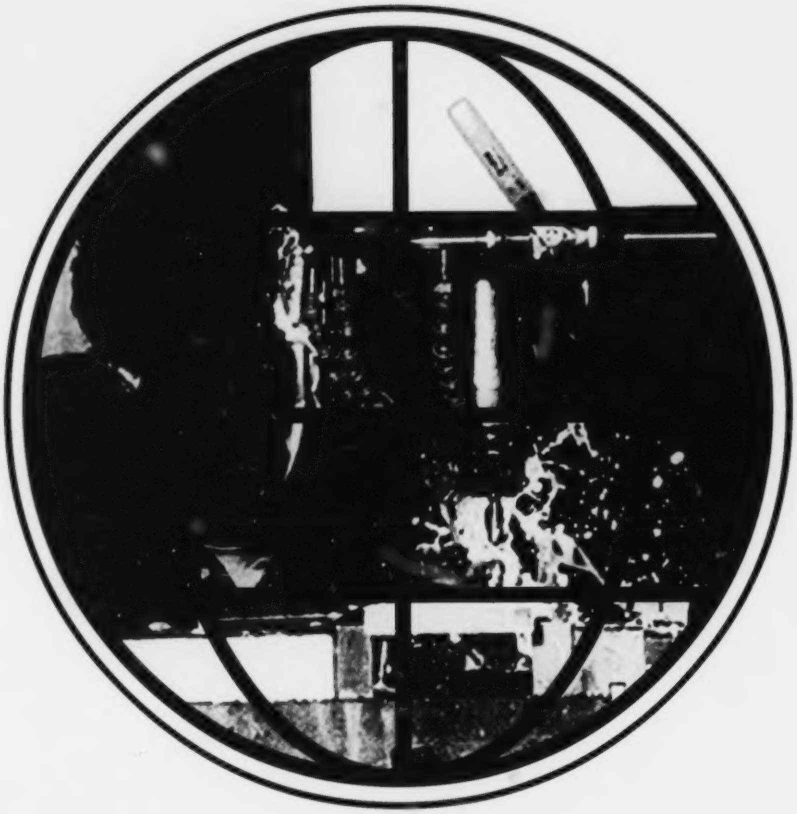
CE 077 017

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY



Welding Series
COURSE SYLLABI

3

Supported by the National Science Foundation's Advanced Technological Education Program

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Welding Series

COURSE SYLLABI

Supported by the National Science Foundation's Advanced Technological Education Program

This material is based upon work supported by the
National Science Foundation under Grant No. DUE-9553716

National Science Foundation
Advanced Technological
Education Program

"Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Foundation."

ACKNOWLEDGEMENTS

This project was made possible by the cooperation and direct support of the following organizations:

National Science Foundation - Division of Undergraduate Education
MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS

Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES

AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES

Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS

Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS

Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER
Central Florida Community College

Central Florica Community College

Dr. Charles R. Dessance, President

Dr. Hugh Rogers, Project Administrator

P.O. Box 1388
Ocala, FL 34478-1388
College phone: 352-873-5823
fax: 352-873-5883
Center phone: 407-384-2155

Manufacturing in Florida

During the past two decades, the Central Florida region near Florida's Space Coast, Melbourne, Cape Canaveral, Coala, Orlando, and the I-4 corridor to Tampa has experienced unprecedented economic growth. This growth has been especially evident in the fields of aerospace, electronics, laser electro-optics, and simulation enterprises. From 1990 to 1997 the area's population grew by more than 13 percent to approximately 4 million.

Manufacturing companies in the region now number more than 3000. The products manufactured range from aerospace to space launch equipment, advanced technology emergency vehicles, to sophisticated electronic and simulation components, circuit boards, laser equipment, wireless data systems, communication devices, and metals fabrication. Much of the nation's aerospace, satellite, and space facilities are concentrated in the region, including NASA, Lockheed Martin, E.G. and G. Inc., Boeing, McDonnell Douglas, Rockwell, Raytheon, Grumman, and Harris Corporation. Electronic companies such as Siemens, AT&T, Lucent, and Motorola serve both U.S. and export markets.

Central Florida, with three interstate highways (I-95, I-4, and I-75), is home to the University of Central Florida, its 27,000 students, and programs which include comprehensive engineering and engineering technology. Central Florida's growth has helped to fuel the State of Florida's growth to fourth largest state in the U.S. with a population of 14.6 million. By 2010 the state's population is projected to increase by more than 13 percent with 9 percent of its total workforce involved in manufacturing.

Central Florida Community College

Central Florida Community College (CFCC), serving a total of 6,000 students, offers a center of emphasis in Electronics, a Manufacturing Technology program with an internship requirement, an Industrial Maintenance/Machining program, a CADD program, and a Computer Design/Application program. Ocala, home of the college, has rapidly become an industrial center, with Lockheed Martin's Microelectronics Circuit Board Facility, and a second plant for Defense/Commercial Satellite Communications Manufacturing. E-One Corporation and other companies contribute to 17 percent of the local workforce being engaged in manufacturing.

Development Team

- **Project Coordinator**: Dr. Hugh Rogers, former Dean of Technical Education; served as the primary administrator and academic coordinator for the MASTER project. He also conducted the occupational skills profile interviews and benchmarked the welding instructional modules with review at four other colleges: Moraine Valley (Palos Hills, IL), IVY Tech (Terra Haute, Ind), Macomb Community College (Sterling Heights, MI), and Henry Ford Community College (Dearborn, MI).
- **Subject Matter** Experts: Mr Bill Rhodes and Mr Doug Wilson were responsible for developing skill standards and course/program materials for the welding technology components of the MASTER project. Other colleges and the American Welding Society.

Introduction

MASTER research indicates that a minimum of one year of occupational study and training will prepare students with the entry-level skills. To prepare an advanced Welding Technician that is knowledgeable in mathematics, metallurgy, welding design and fabrication, requires a two-year or A.S. Degree program. This program equips the student with a more complete understanding and the capability to understand systems and solve problems, while allowing time for practical applications and certifications.

In this two-year program, the students progress through a series of basic welding and general preparatory courses of an excellent nature in composition, technical mathematics, physics, and manufacturing/metallurgical processes. Along with comprehensive hands-on training, students also learn about the various types of materials and processes used by today's manufacturing industries. The Welding program at Central Florida Community College (CFCC) has been training welders for many years and works closely with advisory committee members to ensure that the skills being taught are the skills relevant to industry. Students who graduate from this course of study receive the A.S. Degree in Welding Management Technology from CFCC. Upon graduation, students are able to interpret complex drawings, select the correct materials, and perform all necessary welding processes. The curriculum has been designed to prepare students to enter the welding trades. Laboratory work is emphasized with actual industrial equipment in order to prepare students for interesting, rewarding work in a wide variety of industries. The Welding Management Program falls under the umbrella of Engineering Technology at CFCC. The Welding Department also offers a one-year certificate in welding in exceptional areas of study.

After many interviews with practitioners from industry and discussions with educators, managers, supervisors, and others involved with welding-related occupations, the MASTER Consortium Partners have agreed to present our definition of a welder as follows:

***WELDER** – that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.*

This volume contains the justification, documentation, and course syllabi for the courses which we recommend as minimum training for individuals desiring to become welders.

The first and most important task of the MASTER program was the development of a foundation upon which all other works could be built. The MASTER Competency Profile is this foundation.

These same duties and tasks were then included in both the Texas and National Surveys for further validation. As a result of the surveys, additional refinements were made in the Competency Profiles. These changes were incorporated into the individual course syllabi which were used for the pilot program.

The MASTER Competency Profile for Welder has been included on the following page.

The MASTER Competency Profile

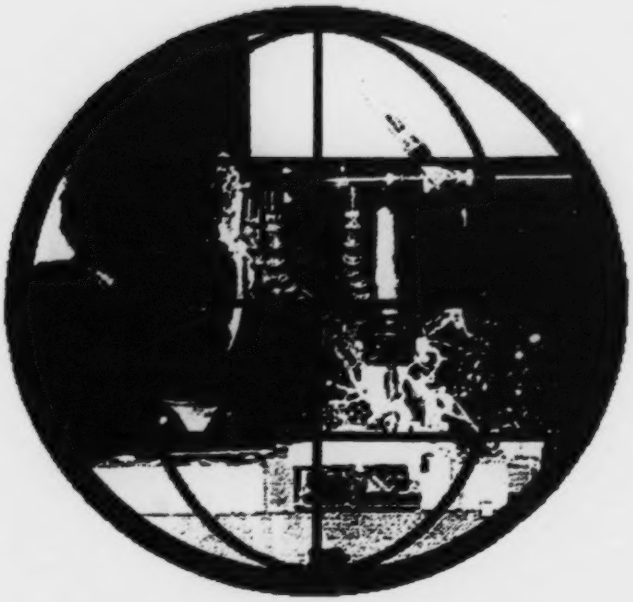
Development of Competency Profiles at each of the MASTER sites began with visits to representative companies for the purpose of surveying expert workers within the industry and occupational areas under investigation. Each site began the survey process by asking a subject matter expert in the targeted technical area, generally a member of its faculty, to employ a modified version of the generally accepted DACUM (Developing A Curriculum) method to categorize the major skills needed to work in the selected occupation. As source materials, the college instructors drew on their professional knowledge and experience of current industry requirements and trends. The initial skill standards developed by the subject matter experts underwent numerous internal reviews and revisions within each site, assuming final form as a series of structured survey and interview questions designed to elicit a simple yes or no response.

To determine an appropriate survey sample, each site compiled a database of its region's small and medium-sized manufacturers and searched for companies likely to employ workers in the targeted occupational area. The resulting cross-industry samples were sorted further to achieve a balance of technological capability and workforce size; the sample companies within each region were then asked to participate in the project. Willing respondents were scheduled for interviews.

During the company interviews, the MASTER staff asked expert workers to identify the primary duties and tasks performed by a typical worker and to consider the special skills and knowledge, traits and attitudes, and industry trends that would have an impact on worker training, employability, and performance both now and in the future. The interview results were analyzed to create individual profiles identifying the most common duties and skills required of workers at each company. Summaries from the interviews of expert workers were then placed in a matrix of competencies and skills and further reviewed and confirmed by company supervisors and specialists. These individual company Competency Profiles served three purposes. First, they showed, in a format that could be easily understood by both industries and educators, a picture of the occupational specialty at a given company at that particular time. Second, these individual company Competency Profiles furnished the company with a document for their ownership. This, in effect, made them real partners in the work of MASTER. Third, they often became the basis of the company's long term training plan. An added benefit was to display this company's skill base to ISO 9000 auditors and others to clarify the skill levels of the workforce.

Data for all companies were then aggregated to develop a composite Competency Profile of industry skill standards within the selected occupational specialty area of Machining, as shown on the following page.

Welding Competency Profile



Job Analysis conducted and prepared by

MASTER

_M_achine Tool _A_dvanced _S_kills
_T_echnology _E_ducational
_R_esources Program
Consortium

WELDING

Technical Workplace Competencies

Duties	Tasks			
A **Follow Safety Practices**	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials
	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station
	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation
	A-13 Mark "hot-work"			
B **Total Quality**	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling
	B-5 Establish methods, plans and procedures to maintain quality			
C **Work Ethics**	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace
	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment
	C-9 Practice a positive attitude			

WELDING

Technical Workplace Competencies

Duties	Tasks			
D **Communication Skills**	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement
	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors	
E **Work as a Team**	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately
	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale
	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills
	E-13 Demonstrate good personal relations skills			
F **Mathematical Skills**	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English Measurements
	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving		
G **Weld-Related Requirements**	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures

WELDING

Technical Workplace Competencies

Duties	Tasks			
H **Blueprinting, Structural Layout and Fit-Up**	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts
	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts
	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs
	H-13 Describe methods for layout slopes and rolling tolerances	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets
	H-17 Describe methods for straightening and removing damaged structural and machinery parts			
I **Set-Up Welding Process(es)**	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment
	I-5 Make test-weld to verify parameters			
J **Prepare Joint for Welding**	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation
K **Oxyacetylene Cutting and Welding**	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality

WELDING

Technical Workplace Competencies

Duties	Tasks			
K **Oxyacetylene Cutting and Welding (continued)**	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting
	K-9 Cut mild steel plate in a safe manner			
L1 **Shield Metal Arc Welding (SMAW) (Basic)**	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique
	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control postweld temperature according to procedures
	L-9 Post clean weld	L-10 Post finish weld		
L2 **Shield Metal Arc Welding (SMAW) (Advanced)**	L-11 Pass a performance qualification test using SMAW on carbon steel pipe in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position		
M1 **Gas Metal Arc Welding (GMAW) (Basic)**	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality
	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys
	M-9 Perform GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds

WELDING

Technical Workplace Competencies

Duties	Tasks			
M2 GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique
	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead
	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities	
M3 GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions
	M-28 Pre-heat joint, if required; understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system
	M-32 Describe weldability problems associated with straight chromium, nickel, & stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position
N Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment
O1 Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality
	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet & groove welds on T and butt joints on various metals in various positions

WELDING

Technical Workplace Competencies

Duties	Tasks			
O2 **Gas Tungsten Arc Welding (GTAW) (Advanced)**	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe		
P **Plasma Arc Cutting and Welding**	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment
	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment	
Q **In-Process Weld Inspection**	Q-1 Check weld size	Q-2 Perform visual inspection		
R **In-Process Rework**	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld
	R-5 Repeat in-process inspection			
S **Housekeeping Activities**	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases
	S-5 Clean work area(s)			
T **Emergency Vehicle Terminology**	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system	

WELDING

Technical Workplace Competencies

Duties

U **Wellness/Physical Abilities**

Tasks

U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours
U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health		

Welder

Skills, Traits and Trends

Skills and Knowledge

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Work in Self-Directed Teams
Knowledge of Welding Equipment and Occupational Procedures
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Improvement Activities
Practice Quality-Consciousness in Performance of the Job

Traits and Attitudes

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Awareness
Motivation
Responsibility
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

Tool/Equipment Proficiency

Mechanic's Tools (e.g., toolbox, wrenches, sockets, hammers, etc.)
Measurement Tools (scales, tapes, calipers, micrometers)
Gages
Fixtures for Layout
Power Tools and Grinders
Drill Presses
Power Saws
Power Drills
Hydraulic/Arbor Press
SMAW Equipment
GMAW Equipment
GTAW Equipment
Plasma Arc Cutter
Oxyacetylene Equipment
Resistance Welder
Air Carbon Arc Cutter
Exothermic Rod Cutter (Mini Torch)
Track Torch
Alignment/Calibration Tools
Computer
Forklift
Personal Safety Equipment
Workbenches
Vises
Pedestal Grinders
Air Compressor
Air Powered Tools
Hydraulic Jack
Chain Hoist

Current Trends

Multiple Skills to Include Fabrication and Assembly
Use of Automated Handling Equipment
Use of Automated Welding Equipment
Environmental Concerns

The MASTER Pilot Program
Curriculum and Course Descriptions

After completing the Competency Profile for each occupational specialty area, each MASTER partner reviewed its existing curriculum against the industry-verified skill standards in order to identify a suitable foundation for new pilot training programs. Because each college had to comply with the requirements of its respective college system and appropriate state agency, the resulting pilot curricula for occupational specialty areas tended to vary in format and academic requirements (e.g., some programs were based on the semester system, others on the quarter system). Despite differences in the curricula developed at the partner colleges, each of the pilot programs was designed to achieve the following two goals mandated in the MASTER grant proposal:

> ***Pilot Program***: "Conduct a one year pilot program with 25 or more selected applicants at each college or advanced technology center to evaluate laboratory content and effectiveness, as measured by demonstrated competencies and indicators of each program area."
>
> ***Student Assessment***: "Identify global skills competencies of program applicants both at point of entrance and point of exit for entry-level and already-employed technicians."
>
> (*Note:* Not all occupational specialty areas were pilot-tested at all Development Centers; however, all partner colleges conducted one or more pilot programs.)

Included on the following page is the curriculum listing for the pilot program which was used to validate course syllabi for this occupational specialty area. The curriculum also shows the number of hours assigned to each of the courses (lecture, laboratory and credit hours). Also included is a description of each of the courses.

MASTER Curriculum
Welding
A.S. Degree Program

		LEC	LAB	CR
FIRST SEMESTER				
WLD 1106	Welding I	20	40	3
WLD 2122	Shielded Metal Arc Welding	20	40	3
WLD 1112	Oxyacetylene Welding	20	40	3
ENC 1101	Freshman Composition Skills I	45	0	3
MTB 1321	Technical Mathematics	45	15	3
SECOND SEMESTER				
WLD 2137	Advanced Welding I	20	40	3
WLD 1101	Blueprint Reading for Welders	30	30	3
WLD 1123	TIG (GTAW) Welding	20	40	3
ISS 1010 *or*	Introduction to the Social Sciences *or*	45	0	3
WOH 1012 *or*	World Civilizations I *or*			
WOH 1022	World Civilizations II			
PHY 1020	Elementary Physics for Non-Science Majors *or* Any Physical Science	45	0	3
THIRD SEMESTER				
WLD 1104	Manufacturing/Metallurgical Processes	30	30	3
HLP 1082	Wellness Applications	30	0	2
FOURTH SEMESTER				
WLD 2132	Advanced Welding II	20	40	3
WLD 2930	Welding Fabrication Techniques	20	40	3
WLD 1161	Pipe Welding	20	40	3
SPC 2600	Effective Speaking	45	0	3
HUM 1021	Introduction to the Humanities	45	0	3
FIFTH SEMESTER				
WLD 2931	Welding Design and Fabrication	20	40	3
WLD 1157	Specialty MIG and Plasma Arc Welding	15	45	3
WLD 1175	Pipe Fitting	15	45	3
	Technical Elective/Specialties	100	200	5
	Program Totals	670	725	64

MASTER Course Descriptions
Welding
(A.S. Degree Program)

First Semester

WLD 1106	**Welding I** (20-40-3) An introductory course including an overview of welding as an occupation, welding terminology, fundamentals of shielded metal arc welding, and oxyacetylene welding and cutting. Basic blueprint reading, metallurgy, welding codes and symbols are also covered. Practical experience will be gained in shielded metal arc welding and oxyacetylene welding and cutting.
WLD 2122	**Shielded Metal Arc Welding** (20-40-3) A course in the fundamentals of arc welding including the operation and setup of the arc welding machine, selection and identification of electrode classifications, and an overview of the steel making process. Practical experience will be gained in arc welding of basic joint configurations using a variety of welding electrodes.
WLD 1112	**Oxyacetylene Welding** (20-40-3) A course in the fundamentals of gas welding including welding terminologies, oxyacetylene welding and cutting procedures, fusion welding in all positions, braze welding, cutting torch operation, gas welding of aluminum and stainless steel, and cast measuring.
ENC 1101	**Freshman Composition Skills I** (45-0-3) The first course in college composition designed to develop skill in writing multi-paragraph essays with emphasis on exposition, including the selection, restriction, organization, and development of topics. It offers the student opportunities to improve CLAST English skills. Students examine selected writing samples as models of form and sources of ideas for the student's own writing.
MTB 1321	**Technical Mathematics** (45-15-3) A course in applied mathematics for students enrolled in technical degree programs. This course teaches algebraic functions, geometry, graphs, fundamentals of trigonometry, and applied statistics as tools to analyze and solve technical problems. Course also includes instruction in measurement tools and test equipment required for precision measurements by technicians or technologists. The scientific calculator will also be used to solve problems in both the English and metric systems.

Second Semester

WLD 2137	**Advanced Welding I** (20-40-30 Intermediate study of metal, industrial practices and procedures, and various testing techniques; arc welding in the flat position, using various thicknesses of metal. Includes structure of the welding program, history of welding, with emphasis on shop safety, welding safety and oxyacetylene safety.
WLD 1101	**Blueprint Reading for Welders** (30-30-3) This course teaches welding symbols and application of these symbols used on blueprints. Design and structural layout in relation to stress and materials will be introduced.
WLD 1123	**TIG (GTAW) Welding** (20-40-3) This course delves into the fundamentals of tungsten inert gas (TIG) welding, including the setup and adjustment of the TIG welding machine, selection of proper tungsten electrodes, selection of filler metals, and the use of various shielding gases, practical experience in TIG welding basic welded joints in stainless and mild carbon steel, aluminum sheet and casting, and magnesium castings.
ISS 1010	**Introduction to Social Sciences** (45-0-3) An introduction to the social sciences and to the major issues facing America today. Topics include population, minorities, cities, crime, poverty, health, the environment, values and international relations.
or	
WOH 1012	**World Civilizations I** (45-0-3) A survey of our past emphasizing the intellectual, cultural, political and economic forces which have shaped our modern heritage from the civilizations of Mesopotamia, Egypt, Greece, Rome, Medieval Christendom, Islam, Africa and the Far East.
or	
WOH 1022	**World Civilizations II** (45-0-3) A survey of the major civilizations of the modern world. Topics include the Age of Reason, the French Revolution, liberalism and socialism, European nationalism, imperialism, the Great War, the Russian Revolution, fascism, national socialism, totalitarianism, World War II, nationalism in Africa and Asia, the Cold War, and the Post-Cold War.
PHY 1020	**Elementary Physics for Non-Science Majors** (45-0-3) This course provides a basic introduction to the several traditional divisions of classical physics. These include mechanics, heat, material properties, molecular and atomic structure, electricity and magnetism, wave motion, including light and sound, optics, radioactivity, and the basic postulates of relativity.

Third Semester

WLD 1104	**Manufacturing and Metallurgical Processes** (30-30-3) This course provides an overview of basic manufacturing processes related to welding as well as the study of the science and technology of metals.
HLP 1082	**Wellness Applications** (30-0-2) This course will cover modules of the basic wellness concepts with concentration on cardiovascular fitness and personal lifestyle improvement.

Fourth Semester

WLD 2132	**Advanced Welding II** (20-40-3) Advanced study of metal, industrial practices and procedures, and various testing techniques; arc welding in the flat position, using various thicknesses of metal. Includes structure of the welding program, history of welding, with emphasis on shop safety, welding safety and oxyacetylene safety.
WLD 2930	**Welding Fabrication Techniques** (20-40-3) This course expands the skills and competencies gained in past welding curriculum. Basic layout and material usage, material identification, and welding process selection will be taught.
WLD 1161	**Pipe Welding** (20-40-3) A course in the fundamentals of pipe welding including pipe welding terminology, oxyacetylene welding and brazing of small diameter pipe, shielded metal arc welding of large diameter pipe. Extensive use of the oxyacetylene cutting process for pipe beveling is an integral aspect of this course.
SPC 2600	**Effective Speaking** (45-0-3) The nature and basic principles of speech, with emphasis on improving speaking and listening skills common to all forms of communication through a variety of experiences in public speaking.
HUM 1021	**Introduction to the Humanities** (45-0-3) An exploration of the arts, ideas and values in Western culture.

Fifth Semester

WLD 2931	**Welding Design and Fabrication** (20-40-3) This course teaches advanced techniques in metal fabrication. Advanced layout and blueprint interpretation will be taught.
WLD 1157	**Specialty MIG and Plasma Arc Welding** (15-45-3) This course is for students in their final semester of the A.S., A.A.S. option and the Occupational Certificate welding programs. This course will cover the

fundamentals of MIG welding, layout work, fabrication, and repair type welding. The student will have the opportunity to fine-tune gas, arc, TIG, and oxyacetylene cutting skills before entering the job market. This course will also cover job-seeking techniques, such as: application forms, resume writing, and interview procedures.

WLD 1175 **Pipe Fitting** (15-45-3) A course covering the fit up and welding of all common pipe configurations. Extensive use of the shielded metal arc welding and the oxyacetylene cutting processes is an integral aspect of this course.

The MASTER
Technical Workplace Competencies
and
Course Crosswalk

After development of appropriate curricula for the pilot programs, each MASTER college began to develop individual course outlines for its assigned specialty area. The skill standards identified in the Competency Profile were cross walked against the technical competencies of the courses in the pilot curriculum. The resulting matrix provided a valuable tool for assessing whether current course content was sufficient or needed to be modified to ensure mastery of entry-level technical competencies. Exit proficiency levels for each of the technical competencies were further validated through industry wide surveys both in Texas and across the nation.

The Technical Workplace Competencies and Course Crosswalk on the following pages presents the match between industry—identified duties and tasks and the pilot curriculum for Welding. Course titles are shown in columns; duties and tasks, in rows. The Exit Proficiency Level Scale (see Figure 1), an ascending scale with 5 as the highest level of proficiency, includes marked boxes indicating whether the task is covered by the instructor during the course; the numbers 1–5 indicate the degree of attention given to the task and the corresponding proficiency expected on the part of the student upon completion of the course of studies. The crosswalk is intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

EXIT PROFICIENCY LEVEL SCALE					
Technical Workplace Competency	**1**	**2**	**3**	**4**	**5**
	Rarely	Routinely with Supervision	Routinely with Limited Supervision	Routinely Without Supervision	Initiates/ Improves/ Modifies and Supervises Others

Figure 1

Included on the following pages is the Technical Workplace Competencies and Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the duties and tasks which were identified by industry as being necessary for entry-level employees have been incorporated into the development of the course syllabi.

Page 1

WELDING TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Welding I	Shielded Metal Arc Welding	Oxyacetylene Welding	Freshman Composition Skills I	Technical Mathematics	Advanced Welding I	Blueprint Reading for Welders	TIG (GTAW) Welding	Intro to Social Sciences	Elementary Physics	Mig /Metallurgical Processes	Wellness Applications	Advanced Welding II	Welding Fabrication Techniques	Pipe Welding	Effective Speaking	Intro to the Humanities	Welding Design and Fabrication	Specialty MIG/Plasma Arc Weld	Pipe Fitting	Exit Proficiency Level
A. FOLLOW SAFETY PRACTICES																					
A-1 Demonstrate understanding of safety rules	I	R	R	P	R	R	R	R		R	R	R	R	R	R	P	P	R	R	R	4
A-2 Assume personal safety standards for self and others	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
A-3 Describe the purpose and use of protective equipment	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
A-4 Demonstrate proper handling of hazardous materials	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	M	R	4
A-5 Demonstrate knowledge of first aid and CPR	I	R	R	P	R	R	R	R	R	R	R	M	M	R	R	P	P	R	M	R	5
A-6 Practice safety precautions when using tools	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
A-7 Demonstrate proper wearing and use of safety equipment	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
A-8 Create and maintain a safe work station	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
A-9 Demonstrate safety precautions regarding ARC flash	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
A-10 Demonstrate eye safety precautions	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
A-11 Perform grinding and brushing technique safety	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
A-12 Maintain adequate ventilation	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
A-13 Mark "hot-work"	I	R	R	P	R	R	R				R	R	M	R	R	P	P	R	R	R	4
B. TOTAL QUALITY																					
B-1 Apply principles and tools of continuous quality improvement	I	R	R	P	R	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	5
B-2 Understand the importance of quality in the manufacturing process	I	R	R	P	R	R	R	R	R	R	M	R	R	R	R	P	P	R	R	R	5
B-3 Implement concepts of quality in the workplace	I	R	R	P	R	R	R	R	R	R	M	R	R	R	R	P	P	R	R	R	5
B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	I	R	R	P	R	R	R	R	R	R	M	R	R	R	R	P	P	R	R	R	5
B-5 Establish methods, plans and procedures to maintain quality	I	R	R	P	R	R	R	R	R	R	M	R	R	R	R	P	P	R	R	R	5
C. WORK ETHICS																					
C-1 Be prompt and on the job in accordance with work schedule	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	5
C-2 Value honest work ethics, dedication, and responsibility in the workplace	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
C-3 Demonstrate high moral values	R	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
C-4 Display a neat and clean workplace	I	R	R	P	R	R	R	R		R	R	R	M	R	R	P	P	R	R	R	4
C-5 Practice careful use and maintenance of tools and equipment	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
C-6 Be committed to excellence and quality	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	5
C-7 Present a good company image in attire and attitude	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4

WLDXWALK.PM6-07/23/98

I=Introduced and Taught R=Repeated and Reinforced M=Mastered P=General Education

Page 2

WELDING TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Welding I	Shielded Metal Arc Welding	Oxyacetylene Welding	Freshman Composition Skills I	Technical Mathematics	Advanced Welding I	Blueprint Reading for Welders	TIG (GTAW) Welding	Intro. to Social Sciences	Elementary Physics	Mig /Metallurgical Processes	Wellness Applications	Advanced Welding II	Welding Fabrication Techniques	Pipe Welding	Effective Speaking	Intro. to the Humanities	Welding Design and Fabrication	Specialty MIG/Plasma Arc Weld.	Pipe Fitting	Exit Proficiency Level
C-8 Support a positive work environment	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
C-9 Practice a positive attitude	I	R	R	P	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	4
D. COMMUNICATION SKILLS																					
D-1 Practice being a good listener	I	R	R	R	R	R	R	R	R	R	R	M	M	R	R	P	P	R	M	R	4
D-2 Demonstrate good reading, comprehension and writing skills	I	R	R	R	R	R	R	R	R	R	R	R	R	R	R	P	P	R	R	R	5
D-3 Document manufacturing processes	I	R	R	R	R	R	R	R	R	R	M	M	R	R	R	P	P	R	R	R	5
D-4 Prepare a recommendation for continuous improvement	I	R	R	R	R	R	R	R	R	R	R	M	M	R	R	P	P	R	R	R	5
D-5 Prepare a summarized priority list of work responsibilities	I	R	R	R	R	R	R	R	R	R	R	M	M	R	R	P	P	R	R	R	5
D-6 Display ability to follow directions, give directions and accept constructive criticism	I	R	R	R	R	R	R	R	R	R	R	M	R	M	R	P	P	R	R	R	5
D-7 Demonstrate positive communication skills with co-workers and supervisors	I	R	R	R	R	R	R	R	R	R	R	M	R	M	R	P	P	R	R	R	5
E. WORK AS A TEAM																					
E-1 Understand the roles of co-workers	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
E-2 Respect peer relationships	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
E-3 Share resources to accomplish necessary tasks	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
E-4 Facilitate the work ethic by completing tasks on time and accurately	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
E-5 Be involved with problem solving	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
E-6 Apply creative thinking	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
E-7 Support a positive attitude	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
E-8 Encourage good feelings and morale	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
E-9 Understand purpose and goals of the organization	I	R	R	P	R	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	5
E-10 Plan and organize work as a team	I	R	R	P	R	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	4
E-11 Be willing to lead in areas of knowledge and expertise	I	R	R	P	R	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	4
E-12 Demonstrate willingness to learn new methods and skills	I	R	R	P	R	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	5
E-13 Demonstate good personal relations skills	I	R	R	P	R	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	4
F. MATHEMATICAL SKILLS																					
F-1 Exhibit understanding of basic arithmetic functions	I	R	R	P	M	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	5
F-2 Exhibit understanding of converting fractions and decimals	I	R	R	P	M	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	5

I=Introduced and Taught R=Repeated and Reinforced M=Mastered P = General Education

WELDING TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Welding I	Shielded Metal Arc Welding	Oxyacetylene Welding	Freshman Composition Skills I	Technical Mathematics	Advanced Welding I	Blueprint Reading for Welders	TIG (GTAW) Welding	Intro. to Social Sciences	Elementary Physics	Mfg./Metallurgical Processes	Wellness Applications	Advanced Welding II	Welding Fabrication Techniques	Pipe Welding	Effective Speaking	Intro. to the Humanities	Welding Design and Fabrication	Specialty MIG/Plasma Arc Weld	Pipe Fitting	Exit Proficiency Level
F-3 Demonstrate practical mathematics in the use of measurement tools	I	R	R	P	M	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	5
F-4 Inter-convert Metric/English measurements	I	R	R	P	M	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	4
F-5 Perform practical mathematical applications relevant to area of work	I	R	R	P	M	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	5
F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving	I	R	R	P	M	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	4
G. WELD-RELATED REQUIREMENTS																					
G-1 Read job method plan	I	R	R	P	R	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	4
G-2 Verify and upgrade paperwork	I	R	R	P	R	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	4
G-3 Interpret drawings and blueprints	I	R	R	P	R	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	5
G-4 Read welding specifications and procedures	I	R	R	P	R	R	R	R	R	R	M	R	M	R	R	P	P	R	R	R	5
H. BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP																					
H-1 Understand parts of blueprint	I	R	R	P	R	R	R	R	R	R	R	R	M	M	R	P	P	R	R	R	5
H-2 Describe alphabet of lines	I	R	R	P	R	R	R	R	R	R	R	R	M	M	R	P	P	R	R	R	4
H-3 Demonstrate tape reading and measurement techniques	I	R	R	P	R	R	R	R	R	R	R	R	M	M	R	P	P	R	R	R	5
H-4 Use framing square to square parts	I	R	R	P	R	R	R	R	R	R	R	R	M	M	R	P	P	R	R	R	4
H-5 Use level and other devices to verify layout	I	R	R	P	R	R	R	R	R	R	R	R	M	M	R	P	P	R	R	R	5
H-6 Understand and interpret shop drawings for precise layout	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
H-7 Demonstrate knowledge of welding symbols	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	5
H-8 Identify various structural shapes and their respective parts	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
H-9 Identify structural components and support frameworks of buildings and their components	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
H-10 Describe proper placement of stiffeners and supports when modifying existing structures	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
H-11 Identify fillet weld sizes for various thicknesses of base metals	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
H-12 Describe proper sequence when cutting various shapes to structural drawing specs	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
H-13 Describe methods for layout slopes and rolling tolerances	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
H-14 Describe the use of jigs and fixtures in layout and fit-up	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
H-15 List the steps to be followed when planning a job	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
H-16 Interpret structural detail sheets	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
H-17 Describe methods for straightening and removing damaged structural and machinery parts	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4

I=Introduced and Taught R=Repeated and Reinforced M=Mastered P=General Education

WELDING TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Welding I	Shielded Metal Arc Welding	Oxyacetylene Welding	Freshman Composition Skills I	Technical Mathematics	Advanced Welding I	Blueprint Reading for Welders	TIG (GTAW) Welding	Intro. to Social Sciences	Elementary Physics	Mfg./Metallurgical Processes	Wellness Applications	Advanced Welding II	Welding Fabrication Techniques	Pipe Welding	Effective Speaking	Intro. to the Humanities	Welding Design and Fabrication	Specialty MIG/Plasma Arc Weld.	Pipe Fitting	Exit Proficiency Level
I. SET-UP WELDING PROCESS(ES)																					
I-1 Gather materials for the job	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
I-2 Gather welding equipment and tools	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
I-3 Check welding equipment for safety	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
I-4 Set-up equipment	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
I-5 Make test-weld to verify parameters	I	R	R	P	R	R	R	R	R	R	M	R	M	M	R	P	P	R	R	R	4
J. PREPARE JOINT FOR WELDING																					
J-1 Prepare joint geometry using mechanical method	I	R	R	P	R	R	R	R	R	R	R	M	R	R	R	P	P	R	R	R	4
J-2 Clean weld area	I	R	R	P	R	R	R	R	R	R	R	M	R	R	R	P	P	R	R	R	4
J-3 Fit-up joint	I	R	R	P	R	R	R	R	R	R	R	M	R	R	R	P	P	R	R	R	4
J-4 Verify joint preparation	I	R	R	P	R	R	R	R	R	R	R	M	R	R	R	P	P	R	R	R	4
K. PERFORM OXYACETYLENE CUTTING AND WELDING																					
K-1 Identify and describe the function of each piece of equipment	I	R	M	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
K-2 Identify the safety hazards	I	R	M	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
K-3 Describe preventive and/or protective measures	1	R	M	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
K-4 List the welding variables and describe their effects on weld quality	I	R	M	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
K-5 Describe the AWS oxyfuel gas welding rod classification system	I	R	M	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
K-6 Describe techniques for preventing or reducing welding related distortion	I	R	M	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	I	R	M	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
K-8 List the variables associated with cutting	I	R	M	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
K-9 Cut mild steel plate in a safe manner	I	R	M	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
L1. SHIELDED METAL ARC WELDING (SMAW) (BASIC)																					
L-1 Preheat joint	I	I	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
L-2 Initiate welding process	I	I	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
L-3 Perform weld sequence	I	I	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
L-4 Control weld technique	I	I	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
L-5 Maintain pre-heat and perform interpass	I	I	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4

I=Introduced and Taught R=Repeated and Reinforced M=Mastered P=General Education

WELDING TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Welding I	Shielded Metal Arc Welding	Oxyacetylene Welding	Freshman Composition Skills I	Technical Mathematics	Advanced Welding I	Blueprint Reading for Welders	TIG (GTAW) Welding	Intro. to Social Sciences	Elementary Physics	Mig /Metallurgical Processes	Wellness Applications	Advanced Welding II	Welding Fabrication Techniques	Pipe Welding	Effective Speaking	Intro. to the Humanities	Welding Design and Fabrication	Specialty MIG/Plasma Arc Weld.	Pipe Fitting	Exit Proficiency Level
L-6 Use the carbon arc process to cut and gouge base weld materials	I	I	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
L-7 Apply welders identification	I	I	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
L-8 Control post-weld temperature according to procedures	I	I	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
L-9 Post clean weld	I	I	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
L-10 Post finish weld	I	I	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
L2. SHIELDED METAL ARC WELDING (SMAW) (ADVANCED)																					
L-11 Pass a performance qualification test using SMAW on carbon steel pipe in the 6G position	I	I	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position	I	I	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M1. GAS METAL ARC WELDING (GMAW) (BASIC I)																					
M-1 Identify GMAW equipment	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-2 Identify the safety hazards	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-3 Describe the preventive and protective measures	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-4 Identify welding variables and their effects upon weld quality	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-5 Troubleshoot equipment	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-6 Describe AWS electrode classification system	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-8 Describe most common weldability problems associated with aluminum and copper alloys	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-9 Perform GMAW fillet and groove welds on T and butt joints on various metals in various positions	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-11 Describe GMAW filler wires	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-12 Demonstrate ability to repair welds	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M2. GMAW SHORT CIRCUIT TRANSFER (INTERMEDIATE)																					
M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-14 Initiate welding process	I	R	R	P	R	M	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-15 Perform weld sequence	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
M-16 Control weld technique	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-17 Understand welding characteristics of various shielding gases	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4

I=Introduced and Taught R=Repeated and Reinforced M=Mastered P = General Education

WELDING TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Welding I	Shielded Metal Arc Welding	Oxyacetylene Welding	Freshman Composition Skills I	Technical Mathematics	Advanced Welding I	Blueprint Reading for Welders	TIG (GTAW) Welding	Intro. to Social Sciences	Elementary Physics	Mfg./Metallurgical Processes	Wellness Applications	Advanced Welding II	Welding Fabrication Techniques	Pipe Welding	Effective Speaking	Intro to the Humanities	Welding Design and Fabrication	Specialty MIG/Plasma Arc Weld	Pipe Fitting	Exit Proficiency Level
M-18 Post-clean weld	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-19 Perform interpass preparation	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-21 Post finish weld	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-22 Describe GMAW filler wires	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-23 Describe basic weld discontinuities	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
M3. GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)																					
M-24 Demonstrate pre-weld cleaning	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-25 Demonstrate interpass cleaning	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-26 Demonstrate adjustment to pulse and spray transfer machines	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-28 Pre-heat joint, if required; understand joint preparation	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-29 Initiate welding process	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-30 Perform weld sequence	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-31 Describe AISI stainless steels classification system	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-33 Describe detrimental effects of vibration on the life of piping systems	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
N. FLUX CORE ARC WELDING (FCAW)																					
N-1 Understand the safety factors using FCAW equipment	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
N-2 Troubleshoot FCAW equipment	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
N-3 Perform weld sequence	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
N-4 Shut down FCAW equipment	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
O1. GAS TUNGSTEN ARC WELDING (GTAW) (BASIC)																					
O-1 Identify GTAW equipment	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
O-2 Identify the safety standards	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5

I=Introduced and Taught R=Repeated and Reinforced M=Mastered P=General Education

WELDING TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Welding I	Shielded Metal Arc Welding	Oxyacetylene Welding	Freshman Composition Skills I	Technical Mathematics	Advanced Welding I	Blueprint Reading for Welders	TIG (GTAW) Welding	Intro. to Social Sciences	Elementary Physics	Mfg./Metallurgical Processes	Wellness Applications	Advanced Welding II	Welding Fabrication Techniques	Pipe Welding	Effective Speaking	Intro. to the Humanities	Welding Design and Fabrication	Specialty MIG/Plasma Arc Weld.	Pipe Fitting	Exit Proficiency Level
O-3 Describe the preventive and protective measures	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
O-4 Identify the welding variables and their effects upon weld quality	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
O-5 Troubleshoot equipment	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
O-6 Describe AWS electrode classification system	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
O-7 Describe AWS filler metal classification system	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
O-8 Perform GTAW fillet & groove welds on T and butt joints on various metals in various positions	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
O2. GAS TUNGSTEN ARC WELDING (GTAW) (ADVANCED)																					
O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
P. PLASMA ARC CUTTING AND WELDING																					
P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	5
P-4 Set-up Plasma Arc Cutting equipment	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
P-5 Set-up Plasma Arc Welding equipment	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
Q. IN-PROCESS WELD INSPECTION																					
Q-1 Check weld size	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
Q-2 Perform visual inspection	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
R. IN-PROCESS REWORK																					
R-1 Remove weld defect and prepare for re-weld	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
R-2 Verify defect removal	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
R-3 Pre-heat weld (if required)	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
R-4 Perform re-weld	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
R-5 Repeat in-process inspection	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4

I=Introduced and Taught R=Repeated and Reinforced M=Mastered P=General Education

WELDING TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Welding I	Shielded Metal Arc Welding	Oxyacetylene Welding	Freshman Composition Skills I	Technical Mathematics	Advanced Welding I	Blueprint Reading for Welders	TIG (GTAW) Welding	Intro. to Social Sciences	Elementary Physics	Mfg./Metallurgical Processes	Wellness Applications	Advanced Welding II	Welding Fabrication Techniques	Pipe Welding	Effective Speaking	Intro. to the Humanities	Welding Design and Fabrication	Specialty MIG/Plasma Arc Weld.	Pipe Fitting	Exit Proficiency Level
S. HOUSEKEEPING ACTIVITIES																					
S-1 Return unused consumables	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
S-2 Store tools	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
S-3 Secure welding equipment	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
S-4 Secure welding gases	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
S-5 Clean work area(s)	I	R	R	P	R	R	R	R	R	R	R	R	M	R	R	P	P	R	R	R	4
T. EMERGENCY VEHICLE TERMINOLOGY																					
T-1 Display a general understanding of emergency vehicle terminology	I			P	R	R	M			R	M	M	M	M		P	P	R	R		4
T-2 Understand the functions of equipment being assembled	I			P	R	R	M			R	M	M	M	M		P	P	R	R		4
T-3 Understand how components relate as a total system	I			P	R	R	M			R	M	M	M	M		P	P	R	R		4
U. WELLNESS/PHYSICAL ABILITIES																					
U-1 Demonstrate ability to lift 50 pounds	I			P	R	R				R	M	M	M	R	R	P	P	R	R	R	4
U-2 Demonstrate ability to tolerate heights up to 100 feet	I			P	R	R				R	M	M	M	R	R	P	P	R	R	R	4
U-3 Ability to work from various positions while standing on concrete for extended periods	I			P	R	R				R	M	M	M	R	R	P	P	R	R	R	4
U-4 Display ability to work in hot/cold environment for 8-10 hours	I			P	R	R				R	M	M	M	R	R	P	P	R	R	R	4
U-5 Present a history of documented regular attendance at work	I			P	R	R				R	M	M	M	R	R	P	P	R	R	R	4
U-6 Apply wellness information to lifestyle to maintain health	I			P	R	R				R	M	M	M	R	R	P	P	R	R	R	4

I=Introduced and Taught R=Repeated and Reinforced M=Mastered P=General Education

SCANS

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" the following five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance:

COMPETENCIES:

Resources: *Identifies, organizes, plans, and allocates resources*
Interpersonal: *Works with others*
Information: *Acquires and uses information*
Systems: *Understands complex inter-relationships*
Technology: *Works with a variety of technologies*

FOUNDATION SKILLS:

Basic Skills: *Reads, writes, performs arithmetic and mathematical operations, listens, and speaks well*
Thinking Skills: *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn, and reasons*
Personal Qualities: *Displays responsibility, self-esteem, sociability, self-management, integrity, and honesty*

Recognizing the value of SCANS proficiencies to job performance as well as the growing mandate in many states to include SCANS activities in course curricula, **MASTER** asked survey respondents to review the SCANS skill sets in the context of the draft skill standards for each occupational specialty area. **MASTER** also incorporated an evaluation of SCANS competencies and foundation skills into its assessment of the pilot training curricula. The results were summarized in a crosswalk that allowed the **MASTER** staff to modify course contents where needed to strengthen the achievement of SCANS competencies.

As soft skills, the SCANS competencies are inherently difficult to quantify. **MASTER** realizes that some faculty will emphasize the SCANS more or less than others. In time, faculty will learn to make these types of SCANS activities an integral and important part of the teaching process.

MASTER Curriculum
Welding
A.S. Degree Program

		LEC	LAB	CR
FIRST SEMESTER				
WLD 1106	Welding I	20	40	3
WLD 2122	Shielded Metal Arc Welding	20	40	3
WLD 1112	Oxyacetylene Welding	20	40	3
ENC 1101	Freshman Composition Skills I	45	0	3
MTB 1321	Technical Mathematics	45	15	3
SECOND SEMESTER				
WLD 2137	Advanced Welding I	20	40	3
WLD 1101	Blueprint Reading for Welders	30	30	3
WLD 1123	TIG (GTAW) Welding	20	40	3
ISS 1010 *or*	Introduction to the Social Sciences *or*	45	0	3
WOH 1012 *or*	World Civilizations I *or*			
WOH 1022	World Civilizations II			
PHY 1020	Elementary Physics for Non-Science Majors	45	0	3
	or			
	Any Physical Science			
THIRD SEMESTER				
WLD 1104	Manufacturing/Metallurgical Processes	30	30	3
HLP 1082	Wellness Applications	30	0	2
FOURTH SEMESTER				
WLD 2132	Advanced Welding II	20	40	3
WLD 2930	Welding Fabrication Techniques	20	40	3
WLD 1161	Pipe Welding	20	40	3
SPC 2600	Effective Speaking	45	0	3
HUM 1021	Introduction to the Humanities	45	0	3
FIFTH SEMESTER				
WLD 2931	Welding Design and Fabrication	20	40	3
WLD 1157	Specialty MIG and Plasma Arc Welding	15	45	3
WLD 1175	Pipe Fitting	15	45	3
	Technical Elective/Specialties	100	200	5
	Program Totals	670	725	64

WLD-1106

MASTER PROGRAM

Welding I

Course Syllabus

Total lecture hours: 20 **Total lab hours: 40** **Credit hours: 3**

COURSE DESCRIPTION:

An introductory course including an overview of welding as an occupation, welding terminology, fundamentals of shielded metal arc welding, and oxyacetylene welding and cutting. Practical experience will be gained in shielded metal arc welding and oxyacetylene welding and cutting.

PREREQUISITES: None

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Identify safety procedures unique to the types of welding covered in this program;
2. Provide guidance for a general understanding of employability;
3. Demonstrate knowledge of welding metallurgy;
4. Demonstrate knowledge of joint design and welding terms;
5. Demonstrate ability to interpret drawings, blueprints, and weld symbols;
6. Increase knowledge of proper application of welding skills;
7. Increase knowledge of American Welding Society Standards (AWS);
8. Demonstrate knowledge of adequate preparation of welding surfaces; and,
9. Increase skill level to pass welding tests offered by an employer.

REQUIRED COURSE MATERIALS:

Textbook: *Welding Technology Today, Principles and Practices*, Craig Stinchcomb, Publisher: Prentice Hall, Inc., New Jersey, Latest Edition

Lab Manual: Student handbook

METHODS OF INSTRUCTION:

Lecture: Presentations and demonstrations.

Laboratory: Practice with coaching and close supervision.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;
2. Instructor's observation of hands-on performance; and,
3. Student closely following safety and shop procedures.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Identify all safety and set-up procedures	
Identify weld symbols and increase knowledge of fabrication skills	
Select and use hand tools and measuring devices and their safety	
Classify metal using charts and tables	
Prepare metal for welding and burning	
Read and implement welding procedures	
Weld and bend test coupons	
Apply shop policies and procedures	
Apply surfacing skills	
Weld multi-pass tee joints in all positions	
Apply gas welding skills	
Apply Shield Metal Arc Welding (SMAW) skills	
Apply Gas Tungsten Arc Welding (GTAW) skills	
Apply Gas Metal Arc Welding (GMAW) skills and Flux Core Arc Welding (FCAW) skills	
Apply plasma arc skills	
Total Lecture Hours	**20**

LAB OUTLINE:

Lab Topics	Contact Hrs.
See Laboratory Handbook	
Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies *required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."*

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- ***A. Resources:*** *Identifies, organizes, plans, and allocates resources*
  1. **Allocates time to complete assigned tasks on schedule**
  2. **Determines and allocates required materials and resources for meeting objectives**
  3. **Evaluates skills, performance, and quality of work and provides feedback**
- ***B. Interpersonal:*** *Works with others*
  1. **Participates as a member of the team, contributing to group effort**
  2. **Provides individual assistance/direction to peers as requested**
  3. **Determines and meets expectations**
  4. **Exercises leadership qualities to effectively communicate ideas and make decisions.**
  5. **Negotiates resources in order to accomplish objectives**
  6. **Works well with all members of the class**
- ***C. Information:*** *Acquires and uses information*
  1. **Acquires and evaluates information**
  2. **Organizes and maintains information**
  3. **Interprets and communicates information**
- ***D. Systems:*** *Understands complex inter-relationships*
  1. **Understands and works well with social, organizational, and technological systems**
  2. **Monitors and corrects performance of system during operation**
  3. **Recommends modifications to system to improve performance**
- ***E. Technology:*** *Works with a variety of technologies*
  1. **Chooses relevant procedures, tools, and equipment**
  2. **Applies appropriate procedures and techniques to accomplish tasks**
  3. **Identifies or solves problems to maintain equipment**

II. FOUNDATION SKILLS

- **A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks**

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    a. **Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts**
    b. **Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study**
    c. **Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)**
    d. **Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner**
    e. **Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials**
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. **Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning**
    b. **Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.**
    c. **Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered**
    d. **Demonstrates ability to complete all required writings in a timely, complete, and professional manner**
    e. **Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments**
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

- a. **Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages**
- b. **Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems**
- c. **Demonstrates ability to understand and perform multi-step computations**
- d. **Demonstrates ability to read, interpret, and use standard measuring devices**
- e. **Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively**
- f. **Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance**
- g. **Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines**

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   - a. **Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery**
   - b. **Demonstrates ability to hear, comprehend, and appropriately follow directions**
   - c. **Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction**
   - d. **Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately**
   - e. **Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds**
   - f. **Demonstrates ability and maturity to seek and receive additional individualized instruction as needed**
5. ***Speaking*****:** *Organizes ideas and communicates orally*
   - a. **Demonstrates appropriate listening and speaking skills in personal conversations**
   - b. **Demonstrates ability to choose and organize appropriate words to effectively communicate**
   - c. **Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation**

- d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
- e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
- f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
- g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes

   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

    - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    - c. Demonstrates ability to focus on task at hand and work to completion
    - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    - e. Demonstrates maturity to take responsibility for actions
    - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks
    - b. Demonstrates ability to separate work and personal behaviors
    - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    - e. Demonstrates ability to accept and use constructive criticism
    - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    - a. Demonstrates appropriate and acceptable social behaviors in interactions
    - b. Demonstrates ability to work cooperatively in individual, team, or group situations
    - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    - c. Demonstrates ability to formulate and follow personal schedules

    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    WLD-A1 through WLD-A13;
    WLD-B1 through WLD-B5;
    WLD-C1 through WLD-C9;
    WLD-D1 through WLD-D7;
    WLD-E1 through WLD-E13;
    WLD-F1 through WLD-F6;
    WLD-G1 through WLD-G4;
    WLD-H1 through WLD-H17;
    WLD-I1 through WLD-I5;
    WLD-J1 through WLD-J4;
    WLD-K1 through WLD-K9;
    WLD-L1 through WLD-L12;
    WLD-M1 through WLD-M35;
    WLD-N1 through WLD-N4;
    WLD-O1 through WLD-O10;
    WLD-P1 through WLD-P7;
    WLD-Q1 through WLD-Q2;
    WLD-R1 through WLD-R5;
    WLD-S1 through WLD-S5;
    WLD-T1 through WLD-T3; and,
    WLD-U1 through WLD-U6.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition

5. *Hobart Audio-Visual Training Program*, Latest Edition
6. *Miller Audio-Visual Training Program*, Latest Edition

WLD 1106
07/081598

WLD-2122

MASTER PROGRAM

Shielded Metal Arc Welding

Course Syllabus

Total lecture hours: 20 **Total lab hours: 40** **Credit hours: 3**

COURSE DESCRIPTION:

A course in the fundamentals of arc welding including the operation and set up of the arc welding machine, selection and identification of electrode classifications, and an overview of the steel making process. Practical experience will be gained in arc welding of basic joint configurations using a variety of welding electrodes.

PREREQUISITES: None

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Identify safety procedures unique to this type of welding;
2. Become proficient in identifying metal;
3. Demonstrate employability skills;
4. Demonstrate knowledge of adequate preparation of welding surfaces;
5. Give a general understanding of American Welding Society (AWS) standards;
6. Identify proper applications with AC and DC welding;
7. Become proficient in applying Shielded Metal Arc Welding (SMAW) skills;
8. Become proficient in SMAW position welding; and,
9. Identify and select proper electrodes size and alloy.

REQUIRED COURSE MATERIALS:

Textbook: *Welding Technology Today, Principles and Practices,* Craig Stinchcomb, Publisher: Prentice Hall, Inc., New Jersey, Latest Edition

Lab Manual: Student handbook

METHODS OF INSTRUCTION:

Lecture: Presentations and demonstrations.

Laboratory: Practice with coaching and close supervision.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;
2. Instructor's observation of hands-on performance; and,
3. Student closely following safety and shop procedures.

LECTURE OUTLINE:

Lecture Topics		Contact Hrs.
Review safety procedures		
Identify metal using appearance, weight, spark test and magnetic properties		
Run beads and apply surfacing skills using SMAW equipment		
Prepare pipe joints for welding		
Weld single pass and multi pass, lap joints, tee joints and butt joints using SMAW equipment		
Weld with low hydrogen electrodes		
Weld guided bend test plates		
Welding inspection and testing		
Cut with SMAW equipment		
Use of current industry standards, practices, and techniques		
Show an ability to ask questions and follow written and oral instructions		
	Total Lecture Hours	**20**

LAB OUTLINE:

Lab Topics		Contact Hrs.
See Laboratory Handbook		
	Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

- I. COMPETENCIES
  - *A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  - *B.* ***Interpersonal:*** *Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  - *C.* ***Information:*** *Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  - *D.* ***Systems:*** *Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  - *E.* ***Technology:*** *Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

- II. FOUNDATION SKILLS
  - A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

- b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
- c. Demonstrates ability to understand and perform multi-step computations
- d. Demonstrates ability to read, interpret, and use standard measuring devices
- e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
- f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
- g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking*:** *Organizes ideas and communicates orally*
    - a. Demonstrates appropriate listening and speaking skills in personal conversations
    - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups

    - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes
    - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

- a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
- b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
- c. Demonstrates ability to visually discriminate in gross and fine imagery
- d. Demonstrates ability to visualize abstractly
- e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   - a. Demonstrates mastery of basic reading, math, and language skills through application
   - b. Demonstrates ability to translate abstract theory into practical application
   - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   - d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   - a. Demonstrates use of simple logic
   - b. Demonstrates ability to distinguish relationships
   - c. Demonstrates ability to determine and isolate factors in relationships
   - d. Demonstrates and applies knowledge through practice
   - e. Recognizes that attitudes, skills, and practice are essential to productivity
   - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner

   - c. Demonstrates ability to focus on task at hand and work to completion
   - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   - e. Demonstrates maturity to take responsibility for actions
   - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
   - a. Presents a positive attitude toward tasks
   - b. Demonstrates ability to separate work and personal behaviors
   - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills

   - f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   WLD-A1 through WLD-A13;
   WLD-B1 through WLD-B5;
   WLD-C1 through WLD-C9;
   WLD-D1 through WLD-D7;
   WLD-E1 through WLD-E13;
   WLD-F1 through WLD-F6;
   WLD-G1 through WLD-G4;
   WLD-H1 through WLD-H17;
   WLD-I1 through WLD-I5;
   WLD-J1 through WLD-J4;
   WLD-K1 through WLD-K9;
   WLD-L1 through WLD-L12;
   WLD-M1 through WLD-M35;
   WLD-N1 through WLD-N4;
   WLD-O1 through WLD-O10;
   WLD-P1 through WLD-P7;
   WLD-Q1 through WLD-Q2;
   WLD-R1 through WLD-R5; and,
   WLD-S1 through WLD-S5.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition
5. *Hobart Audio-Visual Training Program,* Latest Edition
6. *Miller Audio-Visual Training Program,* Latest Edition

WLD-1112

MASTER PROGRAM

Oxyacetylene Welding

Course Syllabus

Total lecture hours: 20 **Total lab hours: 40** **Credit hours: 3**

COURSE DESCRIPTION:

A course in the fundamentals of gas welding including welding terminologies, oxyacetylene welding and cutting procedures, fusion welding in all positions, braze welding, cutting torch operation, gas welding of aluminum and stainless steel, and cast measuring.

PREREQUISITES: **None**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Identify safety and set-up procedures;
2. Demonstrate ability in gas welding skills;
3. Demonstrate ability to cut carbon steel using oxyacetylene equipment;
4. Show ability to pre-heat and form metal using oxyacetylene equipment; and,
5. Increase ability to remove distortion using oxyacetylene equipment.

REQUIRED COURSE MATERIALS:

Textbook: ***Welding Technology Today, Principles and Practices,*** Craig Stinchcomb, Publisher: Prentice Hall, Inc., New Jersey, Latest Edition

Lab Manual: Student handbook

METHODS OF INSTRUCTION:

Lecture: Presentations and demonstrations.

Laboratory: Practice with coaching and close supervision.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;

2. Instructor's observation of hands-on performance; and,
3. Student closely following safety and shop procedures.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Set up and operate oxyacetylene equipment	
Weld and braze using 1/16" filler metal to match parent metal	
Silver braze using Sil-Fox 5 on 2 copper pipe and coupling	
Carry puddles without filler rod	
Carry puddles with filler rod	
Braze mild steel, iron, and copper	
Braze copper to steel	
Braze copper to cast iron	
Observe safety procedures	
Form metal using oxyacetylene equipment	
Total Lecture Hours	**20**

LAB OUTLINE:

Lab Topics	Contact Hrs.
See Laboratory Handbook	
Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**

   A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*

    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** *Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class

C. ***Information:*** *Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
        a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
        b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

    c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

        - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
        - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
    - *4.* ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
        - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
        - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
        - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
        - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
        - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
        - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
    - *5.* ***Speaking:*** *Organizes ideas and communicates orally*
        - a. Demonstrates appropriate listening and speaking skills in personal conversations
        - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
        - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        - g. Demonstrates ability to take responsibility for presentations
- B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    - *1.* ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly

        - e. Demonstrates ability to apply visual imagery to applied tasks
    - *4.* ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
        - a. Demonstrates mastery of basic reading, math, and language skills through application
        - b. Demonstrates ability to translate abstract theory into practical application
        - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        - d. Demonstrates knowledge of good study skills and learning habits
    - *5.* ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        - a. Demonstrates use of simple logic
        - b. Demonstrates ability to distinguish relationships
        - c. Demonstrates ability to determine and isolate factors in relationships
        - d. Demonstrates and applies knowledge through practice
        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly
- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
        - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
        - c. Demonstrates ability to focus on task at hand and work to completion
        - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
        - e. Demonstrates maturity to take responsibility for actions
        - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:** Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions

d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    WLD-A1 through WLD-A13;
    WLD-B1 through WLD-B5;
    WLD-C1 through WLD-C9;
    WLD-D1 through WLD-D7;
    WLD-E1 through WLD-E13;
    WLD-F1 through WLD-F6;
    WLD-G1 through WLD-G4;
    WLD-H1 through WLD-H17;
    WLD-I1 through WLD-I5;
    WLD-J1 through WLD-J4;
    WLD-K1 through WLD-K9;
    WLD-L1 through WLD-L12;
    WLD-M1 through WLD-M35;
    WLD-N1 through WLD-N4;
    WLD-O1 through WLD-O10;
    WLD-P1 through WLD-P7;
    WLD-Q1 through WLD-Q2;
    WLD-R1 through WLD-R5; and,
    WLD-S1 through WLD-S5.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition
5. *Hobart Audio-Visual Training Program,* Latest Edition
6. *Miller Audio-Visual Training Program,* Latest Edition

ENC-1101

MASTER PROGRAM

Freshman Composition Skills I

Course Syllabus

Total lecture hours: 45 **Total lab hours: 0** **Credit hours: 3**

COURSE DESCRIPTION:

The first course in college composition designed to develop skill in writing multi-paragraph essays with emphasis on exposition including the selection, restriction, organization, and development of topics. It offers the student opportunities to improve CLAST English skills. Students examine selected writing samples as models of form and sources of ideas for the student's own writing. (This course has a 6,000 word writing requirement.)

PREREQUISITES: None

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Display a knowledge of writing multi-paragraph essays arranged to provide relevant and specific detail in support of a thesis; they will use varied and sentence patterns and illustrate effective transition;
2. Write mechanically and grammatically correct essays in accordance with the conventions of standard, written American English; and,
3. Write effective essays and reports in other college courses and should pass the writing and English portions of CLAST.

REQUIRED COURSE MATERIALS:

Textbook: *Handbook for Writers*, Lynn Quitman Troyka, Publisher: Simon and Schuster, Latest Edition
The Bedford Reader, X. J. Kennedy and Dorothy M. Kennedy, Publisher: St. Martin's Press, Latest Edition

Lab Manual: None required

METHODS OF INSTRUCTION:

Lecture: Classroom presentations and demonstrations.

Laboratory: None.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Diagnostic tests, objective and essay;
2. Assessment tests, objective and essay;
3. Analytic and holistic evaluation of essays; and,
4. Final Exam.

LECTURE OUTLINE:

Lecture Topics	**Contact Hrs.**
Essays: Eight 500-word essays, four in class and four at home. Two 300-word CLAST practice essays.	
Examinations: One CLAST style comprehensive grammar and mechanics objective exam. One CLAST style final exam – objective and essay (essay counts as 400 words).	
Quizzes: Eight quizzes on selections from the reader will be required. All will be given the first 15 minutes of class; latecomers will not be given extra time and no make-ups will be allowed for these quizzes.	
Research: Topics will be discussed and assigned. The paper must contain a minimum of 1600 words, use at least six sources, and be properly documented.	
Total Lecture Hours	**45**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. ***Interpersonal:*** *Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. ***Information:*** *Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. ***Systems:*** *Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  E. ***Technology:*** *Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
  A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

- b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
- c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
- d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
- e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    - c. Demonstrates ability to understand and perform multi-step computations

    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking*****:** *Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes
    - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery

- b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    - c. Demonstrates ability to visually discriminate in gross and fine imagery
    - d. Demonstrates ability to visualize abstractly
    - e. Demonstrates ability to apply visual imagery to applied tasks
- *4.* ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    - a. Demonstrates mastery of basic reading, math, and language skills through application
    - b. Demonstrates ability to translate abstract theory into practical application
    - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    - d. Demonstrates knowledge of good study skills and learning habits
- *5.* ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    - a. Demonstrates use of simple logic
    - b. Demonstrates ability to distinguish relationships
    - c. Demonstrates ability to determine and isolate factors in relationships
    - d. Demonstrates and applies knowledge through practice
    - e. Recognizes that attitudes, skills, and practice are essential to productivity
    - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

- *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    - c. Demonstrates ability to focus on task at hand and work to completion
    - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors

b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   WLD-D1 through WLD-D7.

MTB-1321

MASTER PROGRAM

Technical Mathematics

Course Syllabus

Total lecture hours: 45 **Total lab hours: 15** **Credit hours: 3**

COURSE DESCRIPTION:

A course in applied mathematics for students enrolled in technical degree programs. This course teaches algebraic functions, geometry, graphs, fundamentals of trigonometry, and applied statistics as tools to analyze and solve technical problems. Course also includes instruction in measurement tools and test equipment required for precision measurements by technicians or technologists. The scientific calculator will also be used to solve problems in both the English and Metric systems.

PREREQUISITES: **Secondary School Mathematics**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to do:
1. Functions;
2. Percents;
3. Basic Algebra;
4. Linear Equations;
5. Plane Geometry; and,
6. Fundamental Trigonometry.

REQUIRED COURSE MATERIALS:

Textbook: *Technical Mathematics,* Robert D. Smith, Publisher: Delmar, Latest Edition

Lab Manual: None required

METHODS OF INSTRUCTION:

Lecture: Presentation and demonstration.

Laboratory: Supervised exercises with measurement applications.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Five tests will be conducted for the purpose of grading.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
1. Review of common fractions	
1.1 Definitions	
1.2 Equivalent fractions	
1.3 Fractions and mixed numbers	
1.4 Arithmetic operations using common fractions	
2. Review of decimal fractions	
2.1 Decimal fractions, in introduction	
2.2 Common fractions and decimal fractions	
2.3 Arithmetic operations using decimal fractions	
2.4 Decimal fraction powers and roots	
2.5 Combined operations of decimal fractions	
3. Percents	
3.1 Definitions	
3.2 Expressing percents as decimal and common fractions	
3.3 Applications of percentage	
4. Fundamentals of algebra	
4.1 Introduction to Algebra (including algebraic expressions)	
4.2 Signed numbers (including meaning of signed numbers, operations using signed numbers, absolute values, arithmetic operations of signed numbers, powers and roots of signed numbers)	
4.3 Basic Algebraic Operations (including definitions, arithmetic operations, using algebraic expressions, powers and roots)	
4.4 Algebraic Equations (including simple algebraic equations, solution of equations using principles of equality, complex equations, solution of	

complex algebraic equations)

5. Linear equations
    - 5.1 Cartesian coordinate systems
    - 5.2 Graphing of linear equation
    - 5.3 Slope of a linear equation
    - 5.4 Equation of a straight line
6. System of equations
    - 6.1 Graphical method of solving linear equations
    - 6.2 Algebraic method of solving linear equations
    - 6.3 Types of systems of equations
    - 6.4 Word problems on system of linear equations
7. Fundamentals of plane geometry
    - 7.1 Introduction
    - 7.2 Angular measurement
    - 7.3 Triangles
    - 7.4 Identical and similar figures
    - 7.5 Polygons
    - 7.6 Circles
8. Computed measures
    - 8.1 Areas of common polygons
    - 8.2 Areas of circles, sectors and segments
    - 8.3 Prisms and Cylinders: Volumes, surface areas, weights
    - 8.4 Pyramids and Cones: Volumes, surface areas, weights (if time permits)
    - 8.5 Spheres: Volumes, surface areas, weights
9. Fundamentals of trigonometry
    - 9.1 Introductions to trigonometric functions
    - 9.2 Trigonometric functions with right triangles
    - 9.3 Practical applications

Total Lecture Hours 45

LAB OUTLINE:

Lab Topics	**Contact Hrs.**
See Laboratory Handbook	
Total Lab Hours	**15**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   - *A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   - *B.* ***Interpersonal:*** *Works with others*
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   - *C.* ***Information:*** *Acquires and uses information*
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   - *D.* ***Systems:*** *Understands complex inter-relationships*
      1. Understands and works well with social, organizational, and technological systems
      2. Monitors and corrects performance of system during operation
      3. Recommends modifications to system to improve performance
   - *E.* ***Technology:*** *Works with a variety of technologies*
      1. Chooses relevant procedures, tools, and equipment
      2. Applies appropriate procedures and techniques to accomplish tasks

3. Identifies or solves problems to maintain equipment

II. **FOUNDATION SKILLS**

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. **Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages**
    b. **Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems**
    c. **Demonstrates ability to understand and perform multi-step computations**
    d. **Demonstrates ability to read, interpret, and use standard measuring devices**
    e. **Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively**
    f. **Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance**
    g. **Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines**
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. **Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery**
    b. **Demonstrates ability to hear, comprehend, and appropriately follow directions**
    c. **Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction**
    d. **Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately**
    e. **Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds**
    f. **Demonstrates ability and maturity to seek and receive additional individualized instruction as needed**
5. ***Speaking:*** *Organizes ideas and communicates orally*
    a. **Demonstrates appropriate listening and speaking skills in personal conversations**
    b. **Demonstrates ability to choose and organize appropriate words to effectively communicate**

- c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
- d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
- e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
- f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
- g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

        e. Demonstrates ability to initiate and effect solution
        f. Demonstrates ability to take responsibility for outcomes
        g. Demonstrates ability to effectively problem solve in individual, team, or group situations
    3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
        a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
        b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
        c. Demonstrates ability to visually discriminate in gross and fine imagery
        d. Demonstrates ability to visualize abstractly
        e. Demonstrates ability to apply visual imagery to applied tasks
    4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*
        a. Demonstrates mastery of basic reading, math, and language skills through application
        b. Demonstrates ability to translate abstract theory into practical application
        c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        d. Demonstrates knowledge of good study skills and learning habits
    5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        a. Demonstrates use of simple logic
        b. Demonstrates ability to distinguish relationships
        c. Demonstrates ability to determine and isolate factors in relationships
        d. Demonstrates and applies knowledge through practice
        e. Recognizes that attitudes, skills, and practice are essential to productivity
        f. Demonstrates ability to discriminate between positive and negative, and act accordingly
C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*

    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement

    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    WLD-A1 through WLD-A13;
    WLD-B1 through WLD-B5;
    WLD-C1 through WLD-C9;
    WLD-D1 through WLD-D7;
    WLD-E1 through WLD-E13;
    WLD-F1 through WLD-F6;
    WLD-G1 through WLD-G4;
    WLD-H1 through WLD-H17;
    WLD-I1 through WLD-I5;
    WLD-J1 through WLD-J4;
    WLD-K1 through WLD-K9;
    WLD-L1 through WLD-L12;
    WLD-M1 through WLD-M35;
    WLD-N1 through WLD-N4;
    WLD-O1 through WLD-O10;
    WLD-P1 through WLD-P7;
    WLD-Q1 through WLD-Q2;
    WLD-R1 through WLD-R5;
    WLD-S1 through WLD-S5;

WLD-T1 through WLD-T3; and,
WLD-U1 through WLD-U6.

MTB 1321
07/061598

MASTER Curriculum
Welding
A.S. Degree Program

		LEC	LAB	CR
FIRST SEMESTER				
WLD 1106	Welding I	20	40	3
WLD 2122	Shielded Metal Arc Welding	20	40	3
WLD 1112	Oxyacetylene Welding	20	40	3
ENC 1101	Freshman Composition Skills I	45	0	3
MTB 1321	Technical Mathematics	45	15	3
SECOND SEMESTER				
WLD 2137	Advanced Welding I	20	40	3
WLD 1101	Blueprint Reading for Welders	30	30	3
WLD 1123	TIG (GTAW) Welding	20	40	3
ISS 1010 *or* WOH 1012 *or* WOH 1022	Introduction to the Social Sciences *or* World Civilizations I *or* World Civilizations II	45	0	3
PHY 1020	Elementary Physics for Non-Science Majors *or* Any Physical Science	45	0	3
THIRD SEMESTER				
WLD 1104	Manufacturing/Metallurgical Processes	30	30	3
HLP 1082	Wellness Applications	30	0	2
FOURTH SEMESTER				
WLD 2132	Advanced Welding II	20	40	3
WLD 2930	Welding Fabrication Techniques	20	40	3
WLD 1161	Pipe Welding	20	40	3
SPC 2600	Effective Speaking	45	0	3
HUM 1021	Introduction to the Humanities	45	0	3
FIFTH SEMESTER				
WLD 2931	Welding Design and Fabrication	20	40	3
WLD 1157	Specialty MIG and Plasma Arc Welding	15	45	3
WLD 1175	Pipe Fitting	15	45	3
	Technical Elective/Specialties	100	200	5
	Program Totals	670	725	64

WLD-2137

MASTER PROGRAM

Advanced Welding I

Course Syllabus

Total lecture hours: 20 **Total lab hours: 40** **Credit hours: 3**

COURSE DESCRIPTION:

Intermediate study of metal properties, industrial practices and procedures, and various testing techniques; arc welding in the flat position, using various thicknesses of metal. Includes structure of the welding program, history of welding, with emphasis on shop safety, welding safety, and oxyacetylene safety.

PREREQUISITES: **None**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Increase knowledge of metallurgy;
2. Demonstrate knowledge on joint design and welding terms;
3. Demonstrate knowledge of proper application of welding skills; and,
4. Increase skill level to pass any welding test offered by an employer.

REQUIRED COURSE MATERIALS:

Textbook: ***Modern Welding,*** Althouse, Turnquist, Bowditch, and Bowditch, Publisher: Goodheart-Wilcox, Latest Edition

Supplemental Text Materials:

Handbook of Welding Procedures, Latest Edition
Hobart Institute Audio Visual Materials, Latest Edition
American Welding Society – Competency Standards
Tool and Manufacturing Engineers Handbook, Society of Manufacturing Engineers, Latest Edition

Lab Manual: None required

METHODS OF INSTRUCTION:

Lecture: Presentation and demonstration.

Laboratory: Practice with coaching and close supervision.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;
2. Instructor's observation of hands-on performance;
3. Student closely following safety and shop procedures; and,
4. Student mastery of competencies.

LECTURE OUTLINE:

Lecture Topics		Contact Hrs.
Identify safety procedures		
Demonstrate knowledge of the preparation of welding surfaces		
Select and use hand tools and measuring devices safely		
Read and implement welding procedures		
Weld and bend test coupons		
	Total Lecture Hours	**20**

LAB OUTLINE:

Lab Topics		Contact Hrs.
See Laboratory Handbook		
	Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
  - 1. Allocates time to complete assigned tasks on schedule
  - 2. Determines and allocates required materials and resources for meeting objectives
  - 3. Evaluates skills, performance, and quality of work and provides feedback
- *B.* ***Interpersonal:*** *Works with others*
  - 1. Participates as a member of the team, contributing to group effort
  - 2. Provides individual assistance/direction to peers as requested
  - 3. Determines and meets expectations
  - 4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  - 5. Negotiates resources in order to accomplish objectives
  - 6. Works well with all members of the class
- *C.* ***Information:*** *Acquires and uses information*
  - 1. Acquires and evaluates information
  - 2. Organizes and maintains information
  - 3. Interprets and communicates information
- *D.* ***Systems:*** *Understands complex inter-relationships*
  - 1. Understands and works well with social, organizational, and technological systems
  - 2. Monitors and corrects performance of system during operation
  - 3. Recommends modifications to system to improve performance
- *E.* ***Technology:*** *Works with a variety of technologies*
  - 1. Chooses relevant procedures, tools, and equipment
  - 2. Applies appropriate procedures and techniques to accomplish tasks
  - 3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

- A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
  - *1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information

from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

c. Demonstrates ability to understand and perform multi-step computations

d. Demonstrates ability to read, interpret, and use standard measuring devices

    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. Demonstrates ability to objectively assess personal strengths and weaknesses
    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    d. Demonstrates ability to identify potential pitfalls and take evasive actions
    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:** Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues

        c. Demonstrates ability to visually discriminate in gross and fine imagery
        d. Demonstrates ability to visualize abstractly
        e. Demonstrates ability to apply visual imagery to applied tasks
    4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
        a. Demonstrates mastery of basic reading, math, and language skills through application
        b. Demonstrates ability to translate abstract theory into practical application
        c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        d. Demonstrates knowledge of good study skills and learning habits
    5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        a. Demonstrates use of simple logic
        b. Demonstrates ability to distinguish relationships
        c. Demonstrates ability to determine and isolate factors in relationships
        d. Demonstrates and applies knowledge through practice
        e. Recognizes that attitudes, skills, and practice are essential to productivity
        f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
        b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
        c. Demonstrates ability to focus on task at hand and work to completion
        d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
        e. Demonstrates maturity to take responsibility for actions

   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors

c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    - WLD-A1 through WLD-A13;
    - WLD-B1 through WLD-B5;
    - WLD-C1 through WLD-C9;
    - WLD-D1 through WLD-D7;
    - WLD-E1 through WLD-E13;
    - WLD-F1 through WLD-F6;
    - WLD-G1 through WLD-G4;
    - WLD-H1 through WLD-H17;
    - WLD-I1 through WLD-I5;
    - WLD-J1 through WLD-J4;
    - WLD-K1 through WLD-K9;
    - WLD-L1 through WLD-L12;
    - WLD-M1 through WLD-M35;
    - WLD-N1 through WLD-N4;
    - WLD-O1 through WLD-O10;
    - WLD-P1 through WLD-P7;
    - WLD-Q1 through WLD-Q2;
    - WLD-R1 through WLD-R5;
    - WLD-S1 through WLD-S5;
    - WLD-T1 through WLD-T3; and,
    - WLD-U1 through WLD-U6.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition
5. *Hobart Audio-Visual Training Program,* Latest Edition
6. *Miller Audio-Visual Training Program,* Latest Edition

WLD-1101

MASTER PROGRAM

Blueprint Reading for Welders

Course Syllabus

Total lecture hours: 30 **Total lab hours: 30** **Credit hours: 3**

COURSE DESCRIPTION:

This course teaches welding symbols and application of these symbols used on blueprints. Design and structural layout in relation to stress and materials will be introduced.

PREREQUISITES: **None**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Interpret welding symbols;
2. Interpret detail drawings;
3. List materials for fabrication from blueprints; and,
4. Develop shop drawings.

REQUIRED COURSE MATERIALS:

Textbook: ***Modern Welding***, Althouse, Turnquist, Bowditch, and Bowditch, Publisher: Goodheart-Wilcox, Latest Edition

Supplemental Text Materials:

Handbook of Welding Procedures, Latest Edition
Hobart Institute Audio Visual Materials, Latest Edition
American Welding Society – Competency Standards
Tool and Manufacturing Engineers Handbook, Society of Manufacturing Engineers, Latest Edition

Lab Manual: Student lab manual

METHODS OF INSTRUCTION:

Lecture: Presentations and demonstrations.

Laboratory: Coaching methods with close supervision.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;
2. Instructor's observation of hands-on performance;
3. Student closely following safety and shop procedures; and,
4. Student mastery of competencies.

LECTURE OUTLINE:

Lecture Topics		Contact Hrs.
Identify welding symbols		
Demonstrate knowledge of fabrication skills		
Demonstrate knowledge of joint design and welding terminology		
Select and use hand tools		
Select and use measuring devices		—
	Total Lecture Hours	**30**

LAB OUTLINE:

Lab Topics		Contact Hrs.
See Laboratory Handbook		—
	Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**
   A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule

    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
- ***B.*** ***Interpersonal:*** *Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
- ***C.*** ***Information:*** *Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
- ***D.*** ***Systems:*** *Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
- ***E.*** ***Technology:*** *Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

- A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    - ***1.*** ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
        - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
        - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
        - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts,

    diagrams, graphs, schematics, blueprints, flow charts, etc.)
    d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*

    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

    a. Demonstrates ability to objectively assess personal strengths and weaknesses

- b. Demonstrates ability to set realistic short-term and long-term goals
- c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
- d. Demonstrates ability to identify potential pitfalls and take evasive actions
- e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
- f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
- g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes
    - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    - c. Demonstrates ability to visually discriminate in gross and fine imagery
    - d. Demonstrates ability to visualize abstractly
    - e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks

   - b. Demonstrates ability to separate work and personal behaviors
   - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    - WLD-A1 through WLD-A13;
    - WLD-B1 through WLD-B5;
    - WLD-C1 through WLD-C9;
    - WLD-D1 through WLD-D7;
    - WLD-E1 through WLD-E13;
    - WLD-F1 through WLD-F6;
    - WLD-G1 through WLD-G4;
    - WLD-H1 through WLD-H17;
    - WLD-I1 through WLD-I5;
    - WLD-J1 through WLD-J4;
    - WLD-K1 through WLD-K9;
    - WLD-L1 through WLD-L12;
    - WLD-M1 through WLD-M35;
    - WLD-N1 through WLD-N4;
    - WLD-O1 through WLD-O10;
    - WLD-P1 through WLD-P7;
    - WLD-Q1 through WLD-Q2;
    - WLD-R1 through WLD-R5;
    - WLD-S1 through WLD-S5; and,
    - WLD-T1 through WLD-T3.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition
5. *Hobart Audio-Visual Training Program,* Latest Edition
6. *Miller Audio-Visual Training Program,* Latest Edition

WLD-1123

MASTER PROGRAM

TIG (GTAW) Welding

Course Syllabus

Total lecture hours: 20 Total lab hours: 40 Credit hours: 3

COURSE DESCRIPTION:

This course delves into the fundamentals of tungsten inert gas (TIG) welding, including the setup and adjustment of the TIG welding machine, selection of proper tungsten electrodes, selection of filler metals, and the use of various shielding gases, practical experience in TIG welding basic welded joints in stainless and mild carbon steel, aluminum sheet and casting, and magnesium castings.

PREREQUISITES: None

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Identify safety procedures unique to this type of welding;
2. Identify proper applications with AC and DC welding;
3. Demonstrate knowledge of adequate preparation of welding surfaces;
4. Give a general understanding of American Welding Society (AWS) standards;
5. Become proficient in applying Gas Tungsten Arc Welding (GTAW) skills on various metals;
6. Demonstrate knowledge of purging and purge backing on specialty applications;
7. Increase knowledge of employability skills; and,
8. Become proficient in applying proper size electrode and proper alloy for filler metal.

REQUIRED COURSE MATERIALS:

Textbook: *Welding Technology Today, Principles and Practices,* Craig Stinchcomb, Publisher: Prentice Hall, Inc., New Jersey, Latest Edition

Lab Manual: Student handbook

METHODS OF INSTRUCTION:

Lecture: Presentations and demonstrations.

Laboratory: Practice with coaching and close supervision.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;
2. Instructor's observation of hands-on performance; and,
3. Student closely following safety and shop procedures.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Assemble TIG (GTAW) equipment	
Review safety procedures with TIG (GTAW) equipment	
Run flat position beads with TIG (GTAW) on ferrous and non-ferrous metals	
Perform TIG welding in 1G, 2G, 3G, and 4G positions	
Apply purging on flat position ferrous and non-ferrous, butt welds with TIG (GTAW) equipment	
Apply purging weld and bend test coupons	
Apply the use of current industry standards, practices and techniques	
Increase the understanding of measuring devices and their use	
Total Lecture Hours	**30**

LAB OUTLINE:

Lab Topics	Contact Hrs.
See Laboratory Handbook	
Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, *full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."*

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. ***Resources:** Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. ***Interpersonal:** Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. ***Information:** Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. ***Systems:** Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  E. ***Technology:** Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
  A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking*****:** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

    d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

  1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. Demonstrates ability to objectively assess personal strengths and weaknesses
    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    d. Demonstrates ability to identify potential pitfalls and take evasive actions
    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions

  2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes

- g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
    - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    - c. Demonstrates ability to visually discriminate in gross and fine imagery
    - d. Demonstrates ability to visualize abstractly
    - e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*
    - a. Demonstrates mastery of basic reading, math, and language skills through application
    - b. Demonstrates ability to translate abstract theory into practical application
    - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    - d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    - a. Demonstrates use of simple logic
    - b. Demonstrates ability to distinguish relationships
    - c. Demonstrates ability to determine and isolate factors in relationships
    - d. Demonstrates and applies knowledge through practice
    - e. Recognizes that attitudes, skills, and practice are essential to productivity
    - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*
    - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

   - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   - c. Demonstrates ability to focus on task at hand and work to completion
   - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   - e. Demonstrates maturity to take responsibility for actions
   - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   - a. Presents a positive attitude toward tasks
   - b. Demonstrates ability to separate work and personal behaviors
   - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules

    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    WLD-A1 through WLD-A12;
    WLD-B1 through WLD-B5;
    WLD-C1 through WLD-C9;
    WLD-D1 through WLD-D7;
    WLD-E1 through WLD-E13;
    WLD-F1 through WLD-F6;
    WLD-G1 through WLD-G4;
    WLD-H1 through WLD-H17;
    WLD-I1 through WLD-I5;
    WLD-J1 through WLD-J4;
    WLD-K1 through WLD-K9;
    WLD-L1 through WLD-L12;
    WLD-M1 through WLD-M35;
    WLD-N1 through WLD-N4;
    WLD-O1 through WLD-O10;
    WLD-P1 through WLD-P7;
    WLD-Q1 through WLD-Q2;
    WLD-R1 through WLD-R5; and,
    WLD-S1 through WLD-S5.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition
5. *Hobart Audio-Visual Training Program,* Latest Edition
6. *Miller Audio-Visual Training Program,* Latest Edition

ISS-1010

MASTER PROGRAM

Introduction to the Social Sciences

Course Syllabus

Total lecture hours: 45 **Total lab hours: 0** **Credit hours: 3**

COURSE DESCRIPTION:

An introduction to the social sciences and to the major issues facing America today. Topics include population, minorities, cities, crime, poverty, health, the environment, values, and international relations. This course has a minimum writing requirement of 3,000 words.

PREREQUISITES: None

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Demonstrate knowledge of the background and nature of the major issues and problems facing America;
2. Demonstrate an ability to weigh the pros and cons of the issues and problems presented and to consider alternative solutions;
3. Demonstrate a knowledge of the American heritage; and,
4. Demonstrate their critical faculties, especially in reading, thinking, speaking and writing.

REQUIRED COURSE MATERIALS:

Textbook: ***Introduction to Social Science and Contemporary Issues,*** Bagby, Publisher: Nelson-Hall, Latest Edition

Lab Manual: None required

METHODS OF INSTRUCTION:

Lecture: Presentations and demonstrations.

Laboratory: None.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests;
2. Class participation; and,
3. Written assignments.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction to the Social Sciences	
Political Perspectives	
Economic Perspectives	
Contemporary Social Issues	
Poverty and Wealth	
Social Stratification	
Prejudice and Discrimination	
Health: Physical and Mental	
Crime and Justice	
Troubled Cities – The Urban Environment	
Population, Pollution and the Natural Environment	
Technology: Challenges and Opportunities	
Defining and Achieving Quality Education	
National Issues Forums (topics vary each year)	
Service Learning – What I can do?	
America's Relations with the World	
Foreign Policies Since 1789	
International Relations	
What's Right About America	
Total Lecture Hours	**45**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- *A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- *B.* ***Interpersonal:*** *Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- *C.* ***Information:*** *Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- *D.* ***Systems:*** *Understands complex inter-relationships*
  1. Understands and works well with social, organizational, and technological systems
  2. Monitors and corrects performance of system during operation
  3. Recommends modifications to system to improve performance
- *E.* ***Technology:*** *Works with a variety of technologies*
  1. Chooses relevant procedures, tools, and equipment
  2. Applies appropriate procedures and techniques to accomplish tasks
  3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

- A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
  - *1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

   - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   - c. Demonstrates ability to understand and perform multi-step computations

d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking*****:** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

  1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
     a. Demonstrates ability to objectively assess personal strengths and weaknesses
     b. Demonstrates ability to set realistic short-term and long-term goals
     c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
     d. Demonstrates ability to identify potential pitfalls and take evasive actions
     e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
     f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
     g. Demonstrates maturity in taking responsibility for decisions
  2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
     a. Demonstrates ability to detect problem through observation, inquiry, or directive
     b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
     c. Demonstrates ability to generate alternatives or options for problem solution
     d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
     e. Demonstrates ability to initiate and effect solution
     f. Demonstrates ability to take responsibility for outcomes
     g. Demonstrates ability to effectively problem solve in individual, team, or group situations
  3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
     a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery

        - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
        - c. Demonstrates ability to visually discriminate in gross and fine imagery
        - d. Demonstrates ability to visualize abstractly
        - e. Demonstrates ability to apply visual imagery to applied tasks
    - *4.* ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
        - a. Demonstrates mastery of basic reading, math, and language skills through application
        - b. Demonstrates ability to translate abstract theory into practical application
        - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        - d. Demonstrates knowledge of good study skills and learning habits
    - *5.* ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        - a. Demonstrates use of simple logic
        - b. Demonstrates ability to distinguish relationships
        - c. Demonstrates ability to determine and isolate factors in relationships
        - d. Demonstrates and applies knowledge through practice
        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly
- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
        - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
        - c. Demonstrates ability to focus on task at hand and work to completion
        - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors

b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    WLD-A2 through WLD-A12;
    WLD-B1 through WLD-B5;
    WLD-C1 through WLD-C3;
    WLD-C5 through WLD-C9;
    WLD-D1 through WLD-D7;
    WLD-E1 through WLD-E13;
    WLD-F1 through WLD-F6;
    WLD-G1 through WLD-G4;
    WLD-H1 through WLD-H17;
    WLD-I1 through WLD-I5;
    WLD-J1 through WLD-J4;
    WLD-K1 through WLD-K9;
    WLD-L1 through WLD-L12;
    WLD-M1 through WLD-M35;
    WLD-N1 through WLD-N4;
    WLD-O1 through WLD-O10;
    WLD-P1 through WLD-P7;
    WLD-Q1 through WLD-Q2;
    WLD-R1 through WLD-R5; and,
    WLD-S1 through WLD-S5.

WOH-1012

MASTER PROGRAM

World Civilizations I

Course Syllabus

Total lecture hours: 45 **Total lab hours: 0** **Credit hours: 3**

COURSE DESCRIPTION:

A survey of our past emphasizing the intellectual, cultural, political and economic forces which have shaped our modern heritage from the civilizations of Mesopotamia, Egypt, Greece, Rome, Medieval Christendom, Islam, Africa and the Far East. This course has a minimum writing requirement of 3,000 words.

PREREQUISITES: **Freshman Composition Skills I**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Demonstrate knowledge of the great (political, intellectual, and artistic) men and women of the past;
2. Demonstrate knowledge of the achievements of past civilizations;
3. Demonstrate knowledge of the important political terms, intellectual concepts, social trends, and artistic schools in history;
4. Demonstrate knowledge of the chronology of history; and,
5. Demonstrate an ability to write satisfactorily a minimum of 3,000 words with accurate information, and in standard, acceptable English.

REQUIRED COURSE MATERIALS:

Textbook:	***Human Venture to 1500, Vol. 1,*** Esler, Publisher: Prentice-Hall, Latest Edition ***Makers of Western Tradition, Vol. I,*** Sowards, Publisher: St. Martin's Press, Latest Edition
Lab Manual:	None required

METHODS OF INSTRUCTION:

Lecture:	Presentations and demonstrations.
Laboratory:	None.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests;
2. Compositions; and,
3. Class discussions.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
The Study of History	
Pre-historic Societies	
Ancient Mesopotamia	
Ancient Egypt	
The Athens of Pericles	
The Hellenistic Age	
The Triumph of Rome	
Christianity	
Byzantium	
Islam	
The Early Middle Ages	
The High Middle Ages	
The Late Middle Ages	
Medieval England to 1453	
The Far East During the Middle Ages	
Renaissance and Reformation Europe	
The Age of Exploration	
Total Lecture Hours	**45**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:** Identifies, organizes, plans, and allocates resources*

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives.
3. Evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:** Works with others*

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. ***Information:** Acquires and uses information*

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. ***Systems:** Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. ***Technology:** Works with a variety of technologies*

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information

    from text and supplemental materials on a level to facilitate productive independent and group study
    c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices

    - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
  - *4.* ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
  - *5.* ***Speaking***: *Organizes ideas and communicates orally*
    - a. Demonstrates appropriate listening and speaking skills in personal conversations
    - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    - g. Demonstrates ability to take responsibility for presentations
- B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. **Demonstrates ability to objectively assess personal strengths and weaknesses**
    b. **Demonstrates ability to set realistic short-term and long-term goals**
    c. **Demonstrates ability to recognize and distinguish between positive and negative alternatives**
    d. **Demonstrates ability to identify potential pitfalls and take evasive actions**
    e. **Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response**
    f. **Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives**
    g. **Demonstrates maturity in taking responsibility for decisions**
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. **Demonstrates ability to detect problem through observation, inquiry, or directive**
    b. **Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation**
    c. **Demonstrates ability to generate alternatives or options for problem solution**
    d. **Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution**
    e. **Demonstrates ability to initiate and effect solution**
    f. **Demonstrates ability to take responsibility for outcomes**
    g. **Demonstrates ability to effectively problem solve in individual, team, or group situations**
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. **Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery**
    b. **Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues**

c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions

- f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   - a. Presents a positive attitude toward tasks
   - b. Demonstrates ability to separate work and personal behaviors
   - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors

c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

WOH-1022

MASTER PROGRAM

World Civilizations II

Course Syllabus

Total lecture hours: 45 **Total lab hours: 0** **Credit hours: 3**

COURSE DESCRIPTION:

A survey of the major civilizations of the modern world. Topics include the Age of Reason, the French Revolution, liberalism and socialism, European nationalism, imperialism, the Great War, the Russian Revolution, fascism, national socialism, totalitarianism, World War II, nationalism in Africa and Asia, the Cold War, and the Post-Cold War. This course has a minimum writing requirement of 3,000 words.

PREREQUISITES: **Freshman Composition Skills I**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Demonstrate knowledge of the great (political, intellectual, and artistic) men and women of the past;
2. Demonstrate knowledge of the achievements of past civilizations;
3. Demonstrate knowledge of the important political terms, intellectual concepts, social trends, and artistic schools in history;
4. Demonstrate knowledge of the chronology of history; and,
5. Demonstrate an ability to write satisfactorily a minimum of 3,000 words with accurate information, and in standard, acceptable English.

REQUIRED COURSE MATERIALS:

Textbook:	***Human Venture Since 1500, Vol. II,*** Esler, Publisher: Prentice-Hall, Latest Edition ***Makers of Western Tradition, Vol. II,*** Sowards, Publisher: St. Martin's Press, Latest Edition
Lab Manual:	None required

METHODS OF INSTRUCTION:

Lecture:	Presentations and demonstrations.

Laboratory: None

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests;
2. Compositions; and,
3. Class discussions.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
The Scientific Revolution and the Age of Reason	
The Age of Absolutism	
The French Revolution	
The Industrial Revolution and Urbanization	
Conservatism, Liberalism, and Socialism	
Nineteenth-Century Nationalism	
Imperialism	
The Great War	
Russia In Revolution	
Fascism and Collectivism	
The Cold War and Bipolarism	
Nationalism in the Non-Western World	
The Third and Fourth Worlds Today	
Total Lecture Hours	**45**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  - *A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  - *B.* ***Interpersonal:*** *Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  - *C.* ***Information:*** *Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  - *D.* ***Systems:*** *Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  - *E.* ***Technology:*** *Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
  - A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
        - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

   - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   - c. Demonstrates ability to understand and perform multi-step computations

    - d. Demonstrates ability to read, interpret, and use standard measuring devices
    - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking*:** *Organizes ideas and communicates orally*
    - a. Demonstrates appropriate listening and speaking skills in personal conversations
    - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. Demonstrates ability to objectively assess personal strengths and weaknesses
    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    d. Demonstrates ability to identify potential pitfalls and take evasive actions
    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery

    - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    - c. Demonstrates ability to visually discriminate in gross and fine imagery
    - d. Demonstrates ability to visualize abstractly
    - e. Demonstrates ability to apply visual imagery to applied tasks
  - *4.* ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    - a. Demonstrates mastery of basic reading, math, and language skills through application
    - b. Demonstrates ability to translate abstract theory into practical application
    - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    - d. Demonstrates knowledge of good study skills and learning habits
  - *5.* ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    - a. Demonstrates use of simple logic
    - b. Demonstrates ability to distinguish relationships
    - c. Demonstrates ability to determine and isolate factors in relationships
    - d. Demonstrates and applies knowledge through practice
    - e. Recognizes that attitudes, skills, and practice are essential to productivity
    - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
  - *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    - c. Demonstrates ability to focus on task at hand and work to completion
    - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

   - e. Demonstrates maturity to take responsibility for actions
   - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:** Believes in own self-worth and maintains a positive view of self*
   - a. Presents a positive attitude toward tasks
   - b. Demonstrates ability to separate work and personal behaviors
   - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:** Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors

b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

WOH 1022
07/06/1998

PHY-1020

MASTER PROGRAM

Elementary Physics for Non-Science Majors

Course Syllabus

Total lecture hours: 45 **Total lab hours: 0** **Credit hours: 3**

COURSE DESCRIPTION:

This course provides a basic introduction to the several traditional divisions of classical physics. These include mechanics, heat material properties, molecular and atomic structure, electricity and magnetism, wave motion, including light and sound, optics, radioactivity, and the basic postulates of relativity.

PREREQUISITES: **One year of high school algebra or equivalent.**
Recommended – one year of high school geometry.

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Demonstrate a basic understanding of each of the divisions of physics enumerated above;
2. Demonstrate how to think analytically by investigation of problems in the various physics areas studied;
3. Demonstrate how to better understand popular literature by becoming familiar with scientific terms, units and notation; and,
4. Demonstrate methods of scientific thinking, inquiry and analysis.

REQUIRED COURSE MATERIALS:

Textbook: *Conceptual Physics,* Hewitt, Publisher: Scott, Foresman and Co., Latest Edition

Lab Manual: None required

METHODS OF INSTRUCTION:

Lecture: Classroom presentations and demonstrations.

Laboratory: None.

Method of Evaluation: Student mastery of the course material is determined by four written, one-hour tests. These tests are half objective type and half written discussion. Grading is not class-curved. If a student misses one test he is given 70% of his average on the other three tests for the one missed test. This does not apply to the last test which must be taken for course completion. No test is dropped.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Preliminary Considerations: Units, scalars vs. Vectors, Symbols, Scientific Notation	
Motion (Linear): Distance vs. Displacement, Speed Velocity, Acceleration, Force and Motion, Newton's Laws, The Motion Equations, Falling Bodies, Motion Graphs, Linear Momentum	
Circular Motion: Angular vs. Linear Quantities, Frequency and Period, Centripetal and Centrifugal Forces, Angular Momentum, Kepler Laws, Torque and Levers	
Work-Energy-Power: Work, Potential and Kinetic Energies, Energy Conservation, Power	
Temperature and Heat: Temperature, Specific Heat, Calorie, B.T.U., Heats of Fusion and Vaporization, Thermodynamics, Heat Transfer	
Matter: Density, Specific Gravity, States of Matter, Pressure, Buoyancy, Gas Law, Kinetic-Molecular Theory	
Elements-Atoms-Molecules-Compounds: Electrons, Protons, Neutrons, Isotopes and Subnuclear Particles	
Electricity and Magnetism: Electrostatics, Currents, Fields, Circuits, DC/AC, Ohm's Law, Power, Measurements, Series and Parallel Arrangements, Magnetics, Meters, Motors, Generators, Transformers	
Wave Motion: Transverse, Longitudinal, Sine Wave, Wavelength, Sound Waves, EM Waves, Light, Inverse Square Law, Reflection, Refraction, Dispersion	
Radioactivity: a, b, y Radiation, Transmutation,	

Half-Life
Relativity: Special Theory, General Theory,
Comments

Total Lecture Hours 45

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   - *A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   - *B.* ***Interpersonal:*** *Works with others*
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   - *C.* ***Information:*** *Acquires and uses information*
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   - *D.* ***Systems:*** *Understands complex inter-relationships*
      1. Understands and works well with social, organizational, and technological systems

   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. Technology: *Works with a variety of technologies*

   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

   1. Reading: *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

   2. Writing: *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

      a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
      b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking***: *Organizes ideas and communicates orally*

a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. Demonstrates ability to detect problem through observation, inquiry, or directive

- b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
- c. Demonstrates ability to generate alternatives or options for problem solution
- d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
- e. Demonstrates ability to initiate and effect solution
- f. Demonstrates ability to take responsibility for outcomes
- g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    - c. Demonstrates ability to visually discriminate in gross and fine imagery
    - d. Demonstrates ability to visualize abstractly
    - e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    - a. Demonstrates mastery of basic reading, math, and language skills through application
    - b. Demonstrates ability to translate abstract theory into practical application
    - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    - d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    - a. Demonstrates use of simple logic
    - b. Demonstrates ability to distinguish relationships
    - c. Demonstrates ability to determine and isolate factors in relationships
    - d. Demonstrates and applies knowledge through practice

        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
        - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
        - c. Demonstrates ability to focus on task at hand and work to completion
        - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
        - e. Demonstrates maturity to take responsibility for actions
        - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
    - *2.* ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
        - a. Presents a positive attitude toward tasks
        - b. Demonstrates ability to separate work and personal behaviors
        - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
        - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
        - e. Demonstrates ability to accept and use constructive criticism
        - f. Accepts positive reinforcement in an appropriate manner
    - *3.* ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
        - a. Demonstrates appropriate and acceptable social behaviors in interactions
        - b. Demonstrates ability to work cooperatively in individual, team, or group situations
        - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    WLD-A1 through WLD-A12;
    WLD-B1 through WLD-B5;
    WLD-C1 through WLD-C9;
    WLD-D1 through WLD-D7;
    WLD-E1 through WLD-E13;
    WLD-F1 through WLD-F6;
    WLD-G1 through WLD-G4;
    WLD-H1 through WLD-H17;
    WLD-I1 through WLD-I5;
    WLD-J1 through WLD-J4;
    WLD-K1 through WLD-K9;
    WLD-L1 through WLD-L12;
    WLD-M1 through WLD-M35;
    WLD-N1 through WLD-N4;

WLD-O1 through WLD-O10;
WLD-P1 through WLD-P7;
WLD-Q1 through WLD-Q2;
WLD-R1 through WLD-R5;
WLD-S1 through WLD-S5;
WLD-T1 through WLD-T3; and,
WLD-U1 through WLD-U6.

2. Library reference materials

PHY 1020
07/061698

MASTER Curriculum
Welding
A.S. Degree Program

		LEC	LAB	CR
FIRST SEMESTER				
WLD 1106	Welding I	20	40	3
WLD 2122	Shielded Metal Arc Welding	20	40	3
WLD 1112	Oxyacetylene Welding	20	40	3
ENC 1101	Freshman Composition Skills I	45	0	3
MTB 1321	Technical Mathematics	45	15	3
SECOND SEMESTER				
WLD 2137	Advanced Welding I	20	40	3
WLD 1101	Blueprint Reading for Welders	30	30	3
WLD 1123	TIG (GTAW) Welding	20	40	3
ISS 1010 *or* WOH 1012 *or* WOH 1022	Introduction to the Social Sciences *or* World Civilizations I *or* World Civilizations II	45	0	3
PHY 1020	Elementary Physics for Non-Science Majors *or* Any Physical Science	45	0	3
THIRD SEMESTER				
WLD 1104	Manufacturing/Metallurgical Processes	30	30	3
HLP 1082	Wellness Applications	30	0	2
FOURTH SEMESTER				
WLD 2132	Advanced Welding II	20	40	3
WLD 2930	Welding Fabrication Techniques	20	40	3
WLD 1161	Pipe Welding	20	40	3
SPC 2600	Effective Speaking	45	0	3
HUM 1021	Introduction to the Humanities	45	0	3
FIFTH SEMESTER				
WLD 2931	Welding Design and Fabrication	20	40	3
WLD 1157	Specialty MIG and Plasma Arc Welding	15	45	3
WLD 1175	Pipe Fitting	15	45	3
	Technical Elective/Specialties	100	200	5
	Program Totals	670	725	64

Third Semester

WLD-1104

MASTER PROGRAM

Manufacturing and Metallurgical Processes

Course Syllabus

Total lecture hours: 30 **Total lab hours: 30** **Credit hours: 3**

COURSE DESCRIPTION:

This course provides an overview of basic manufacturing processes related to welding as well as the study of the science and technology of metals.

PREREQUISITES: **None**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Demonstrate understanding of shop safety;
2. Demonstrate the effects of heat on a structure;
3. Understand distortion control;
4. Demonstrate understanding of metal, when certain alloy elements are added; and,
5. Understand chemical, physical, and mechanical properties of metal.

REQUIRED COURSE MATERIALS:

Textbook: ***Modern Welding***, Althouse, Turnquist, Bowditch, and Bowditch, Publisher: Goodheart-Wilcox, Latest Edition

Supplemental Text Materials:

Handbook of Welding Procedures, Latest Edition
Hobart Audio-Visual Training Program, Latest Edition
American Welding Society – Competency Standards
Miller Audio-Visual Training Program, Latest Edition
Tool and Manufacturing Engineers Handbook, Society of Manufacturing Engineers, Latest Edition

Lab Manual: Student handbook

METHODS OF INSTRUCTION:

Lecture: Presentation and demonstration.

Laboratory: Practice with coaching and close supervision.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;
2. Instructor's observation of hands-on performance;
3. Student closely following safety and shop procedures; and,
4. Student mastery of competencies.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Understand shop safety	
Identify heat effected zones on metal	
Identify corrosion-resistant qualities of metal	
Understand the crystallization of certain metals	
Understand the cooling effects on metal	
Identify the components of steel	
Total Lecture Hours	30

LAB OUTLINE:

Lab Topics	Contact Hrs.
See Laboratory Handbook	
Total Lab Hours	30

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- **A.** ***Resources:*** *Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- **B.** ***Interpersonal:*** *Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- **C.** ***Information:*** *Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- **D.** ***Systems:*** *Understands complex inter-relationships*
  1. Understands and works well with social, organizational, and technological systems
  2. Monitors and corrects performance of system during operation
  3. Recommends modifications to system to improve performance
- **E.** ***Technology:*** *Works with a variety of technologies*
  1. Chooses relevant procedures, tools, and equipment
  2. Applies appropriate procedures and techniques to accomplish tasks
  3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

- **A.** **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
  1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
     - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
     - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information

from text and supplemental materials on a level to facilitate productive independent and group study
    - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    - c. Demonstrates ability to understand and perform multi-step computations
    - d. Demonstrates ability to read, interpret, and use standard measuring devices

        - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
        - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
        - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
    - *4.* ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
        - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
        - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
        - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
        - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
        - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
        - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
    - *5.* ***Speaking*:** *Organizes ideas and communicates orally*
        - a. Demonstrates appropriate listening and speaking skills in personal conversations
        - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
        - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        - g. Demonstrates ability to take responsibility for presentations
- B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. Demonstrates ability to objectively assess personal strengths and weaknesses
    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    d. Demonstrates ability to identify potential pitfalls and take evasive actions
    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues

c. Demonstrates ability to visually discriminate in gross and fine imagery

d. Demonstrates ability to visualize abstractly

e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*

a. Demonstrates mastery of basic reading, math, and language skills through application

b. Demonstrates ability to translate abstract theory into practical application

c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process

d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*

a. Demonstrates use of simple logic

b. Demonstrates ability to distinguish relationships

c. Demonstrates ability to determine and isolate factors in relationships

d. Demonstrates and applies knowledge through practice

e. Recognizes that attitudes, skills, and practice are essential to productivity

f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner

c. Demonstrates ability to focus on task at hand and work to completion

d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

e. Demonstrates maturity to take responsibility for actions

   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors

c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    - WLD-A1 through WLD-A13;
    - WLD-B1 through WLD-B5;
    - WLD-C1 through WLD-C9;
    - WLD-D1 through WLD-D7;
    - WLD-E1 through WLD-E13;
    - WLD-F1 through WLD-F6;
    - WLD-G1 through WLD-G4;
    - WLD-H1 through WLD-H17;
    - WLD-I1 through WLD-I5;
    - WLD-J1 through WLD-J4;
    - WLD-K1 through WLD-K9;
    - WLD-L1 through WLD-L12;
    - WLD-M1 through WLD-M35;
    - WLD-N1 through WLD-N4;
    - WLD-O1 through WLD-O10;
    - WLD-P1 through WLD-P7;
    - WLD-Q1 through WLD-Q2;
    - WLD-R1 through WLD-R5;
    - WLD-S1 through WLD-S5;
    - WLD-T1 through WLD-T3; and,
    - WLD-U1 through WLD-U6.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition
5. *Hobart Audio-Visual Training Program,* Latest Edition
6. *Miller Audio-Visual Training Program,* Latest Edition

HLP-1082

MASTER PROGRAM

Wellness Applications

Course Syllabus

Total lecture hours: 30 **Total lab hours: 0** **Credit hours: 2**

COURSE DESCRIPTION:

This course will cover modules of the basic wellness concepts with concentration on cardiovascular fitness and personal lifestyle improvement.

PREREQUISITES: None

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Assess one's health and fitness levels by evaluation in lifestyles, fitness components, stress management, nutrition and weight control; and,
2. Develop self-improvement plans based on the concepts developed in class.

REQUIRED COURSE MATERIALS:

Textbook: *Wellness Concepts & Applications,* Anspaugh, Hamrick & Rosato, Publisher: Mosby, Latest Edition

Lab Manual: None required

METHODS OF INSTRUCTION:

Lecture: Presentation and demonstration.

Laboratory: None.

Method of Evaluation: Grades will be determined by the use of quizzes/tests, reports, and a student plan for improvement, as well as student class participation. Attendance is required.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Life Scan Profile	
Targeted Heart Rate	

Monitor Individual Heart Rate
Cardiovascular Endurance
Muscular Strength
Cholesterol Analysis Discussion
Blood Sugar Analysis Discussion
Pulmonary Assessment Discussion
Muscular and Skeletal Flexibility
    Assessment
Stress and Recovery Levels
Nutrition Guidelines
Nutritional Analysis
Development of methods and plans
    for improvement of overall health
    and well-being
Evaluation of lifestyle improvement after
    following self-improvement plan

Total Lecture Hours 30

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. ***Interpersonal:*** *Works with others*
    1. Participates as a member of the team, contributing to group effort

2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. ***Information:** Acquires and uses information*

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. ***Systems:** Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. ***Technology:** Works with a variety of technologies*

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

   - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   - c. Demonstrates ability to understand and perform multi-step computations
   - d. Demonstrates ability to read, interpret, and use standard measuring devices
   - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

- a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
- b. Demonstrates ability to hear, comprehend, and appropriately follow directions
- c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
- d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
- e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
- f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking**: Organizes ideas and communicates orally*
    - a. Demonstrates appropriate listening and speaking skills in personal conversations
    - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions

e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application

        c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        d. Demonstrates knowledge of good study skills and learning habits
    5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        a. Demonstrates use of simple logic
        b. Demonstrates ability to distinguish relationships
        c. Demonstrates ability to determine and isolate factors in relationships
        d. Demonstrates and applies knowledge through practice
        e. Recognizes that attitudes, skills, and practice are essential to productivity
        f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
        b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
        c. Demonstrates ability to focus on task at hand and work to completion
        d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
        e. Demonstrates maturity to take responsibility for actions
        f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
    2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
        a. Presents a positive attitude toward tasks
        b. Demonstrates ability to separate work and personal behaviors
        c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
        d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors

e. Demonstrates ability to accept and use constructive criticism
f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    WLD-A1 through WLD-A13;
    WLD-B1 through WLD-B5;

WLD-C1 through WLD-C9;
WLD-D1 through WLD-D7;
WLD-E1 through WLD-E13;
WLD-F1 through WLD-F6;
WLD-G1 through WLD-G4;
WLD-H1 through WLD-H17;
WLD-I1 through WLD-I5;
WLD-J1 through WLD-J4;
WLD-K1 through WLD-K9;
WLD-L1 through WLD-L12;
WLD-M1 through WLD-M35;
WLD-N1 through WLD-N4;
WLD-O1 through WLD-O10;
WLD-P1 through WLD-P7;
WLD-Q1 through WLD-Q2;
WLD-R1 through WLD-R5;
WLD-S1 through WLD-S5; and,
WLD-U1 through WLD-U6.

HLP 1062
07/061798

MASTER Curriculum
Welding
A.S. Degree Program

		LEC	LAB	CR
FIRST SEMESTER				
WLD 1106	Welding I	20	40	3
WLD 2122	Shielded Metal Arc Welding	20	40	3
WLD 1112	Oxyacetylene Welding	20	40	3
ENC 1101	Freshman Composition Skills I	45	0	3
MTB 1321	Technical Mathematics	45	15	3
SECOND SEMESTER				
WLD 2137	Advanced Welding I	20	40	3
WLD 1101	Blueprint Reading for Welders	30	30	3
WLD 1123	TIG (GTAW) Welding	20	40	3
ISS 1010 *or* WOH 1012 *or* WOH 1022	Introduction to the Social Sciences *or* World Civilizations I *or* World Civilizations II	45	0	3
PHY 1020	Elementary Physics for Non-Science Majors *or* Any Physical Science	45	0	3
THIRD SEMESTER				
WLD 1104	Manufacturing/Metallurgical Processes	30	30	3
HLP 1082	Wellness Applications	30	0	2
FOURTH SEMESTER				
WLD 2132	Advanced Welding II	20	40	3
WLD 2930	Welding Fabrication Techniques	20	40	3
WLD 1161	Pipe Welding	20	40	3
SPC 2600	Effective Speaking	45	0	3
HUM 1021	Introduction to the Humanities	45	0	3
FIFTH SEMESTER				
WLD 2931	Welding Design and Fabrication	20	40	3
WLD 1157	Specialty MIG and Plasma Arc Welding	15	45	3
WLD 1175	Pipe Fitting	15	45	3
	Technical Elective/Specialties	100	200	5
	Program Totals	670	725	64

Fourth Semester

WLD-2132

MASTER PROGRAM

Advanced Welding II

Course Syllabus

Total lecture hours: 20 **Total lab hours: 40** **Credit hours: 3**

COURSE DESCRIPTION:

Advanced study of metal properties, industrial practices and procedures, and various testing techniques; arc welding in the flat position, using various thicknesses of metal. Includes structure of the welding program, history of welding, with emphasis on shop safety, welding safety, and oxyacetylene safety.

PREREQUISITES: **None**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Demonstrate shop safety;
2. Identify metals;
3. Demonstrate appropriate communication skills;
4. Demonstrate testing techniques for welding soundness;
5. Demonstrate knowledge of joint design and welding terms; and,
6. Increase knowledge of proper application of welding skills.

REQUIRED COURSE MATERIALS:

Textbook: *Modern Welding,* Althouse, Turnquist, Bowditch, and Bowditch, Publisher: Goodheart-Wilcox, Latest Edition

Supplemental Text Materials:

Handbook of Welding Procedures, Latest Edition
Hobart Audio-Visual Training Program, Latest Edition
American Welding Society – Competency Standards
Miller Audio-Visual Training Program, Latest Edition
Tool and Manufacturing Engineers Handbook, Society of Manufacturing Engineers, Latest Edition

Lab Manual: None required

METHODS OF INSTRUCTION:

Lecture: Presentations and demonstrations.

Laboratory: Practice with coaching and close supervision.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;
2. Instructor's observation of hands-on performance;
3. Student closely following safety and shop procedures; and,
4. Student mastery of competencies.

LECTURE OUTLINE:

Lecture Topics		Contact Hrs.
Safety procedures to be followed in welding shop operations		
Identify welding symbols and increase knowledge of fabrication skills		
An explanation of A.W.S. (American Welding Society) welding standards		
Understand the variables in weld joint design		
	Total lecture hours	**20**

LAB OUTLINE:

Lab Topics		Contact Hrs.
See Laboratory Handbook		
	Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. ***Interpersonal:*** *Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. ***Information:*** *Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. ***Systems:*** *Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  E. ***Technology:*** *Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
  A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations

    - d. Demonstrates ability to read, interpret, and use standard measuring devices
    - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking*:** *Organizes ideas and communicates orally*
    - a. Demonstrates appropriate listening and speaking skills in personal conversations
    - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

- a. Demonstrates ability to objectively assess personal strengths and weaknesses
- b. Demonstrates ability to set realistic short-term and long-term goals
- c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
- d. Demonstrates ability to identify potential pitfalls and take evasive actions
- e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
- f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
- g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

- a. Demonstrates ability to detect problem through observation, inquiry, or directive
- b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
- c. Demonstrates ability to generate alternatives or options for problem solution
- d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
- e. Demonstrates ability to initiate and effect solution
- f. Demonstrates ability to take responsibility for outcomes
- g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

- a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery

- b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
- c. Demonstrates ability to visually discriminate in gross and fine imagery
- d. Demonstrates ability to visualize abstractly
- e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    - a. Demonstrates mastery of basic reading, math, and language skills through application
    - b. Demonstrates ability to translate abstract theory into practical application
    - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    - d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    - a. Demonstrates use of simple logic
    - b. Demonstrates ability to distinguish relationships
    - c. Demonstrates ability to determine and isolate factors in relationships
    - d. Demonstrates and applies knowledge through practice
    - e. Recognizes that attitudes, skills, and practice are essential to productivity
    - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    - c. Demonstrates ability to focus on task at hand and work to completion
    - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors

b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    WLD-A1 through WLD-A13;
    WLD-B1 through WLD-B5;
    WLD-C1 through WLD-C9;
    WLD-D1 through WLD-D7;
    WLD-E1 through WLD-E13;
    WLD-F1 through WLD-F6;
    WLD-G1 through WLD-G4;
    WLD-H1 through WLD-H17;
    WLD-I1 through WLD-I5;
    WLD-J1 through WLD-J4;
    WLD-K1 through WLD-K9;
    WLD-L1 through WLD-L12;
    WLD-M1 through WLD-M35;
    WLD-N1 through WLD-N4;
    WLD-O1 through WLD-O10;
    WLD-P1 through WLD-P7;
    WLD-Q1 through WLD-Q2;
    WLD-R1 through WLD-R5;
    WLD-S1 through WLD-S5;
    WLD-T1 through WLD-T3; and,
    WLD-U1 through WLD-U6.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition
5. *Hobart Audio-Visual Training Program,* Latest Edition
6. *Miller Audio-Visual Training Program,* Latest Edition

MASTER PROGRAM

Welding Fabrication Techniques

Course Syllabus

Total lecture hours: 20 **Total lab hours: 40** **Credit hours: 3**

COURSE DESCRIPTION:

This course expands the skills and competencies gained in past welding curriculum. Basic layout and material usage, material identification, and welding process selection will be taught.

PREREQUISITES: **None**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Demonstrate shop safety;
2. Understand basic layout of materials;
3. Demonstrate proper material identification and usage;
4. Select welding processes, as most appropriate to the job; and,
5. Understand measurement tools.

REQUIRED COURSE MATERIALS:

Textbook: ***Modern Welding***, Althouse, Turnquist, Bowditch, and Bowditch, Publisher: Goodheart-Wilcox, Latest Edition

Supplemental Text Materials:

Handbook of Welding Procedures, Latest Edition
Hobart Audio-Visual Training Program, Latest Edition
American Welding Society – Competency Standards
Miller Audio-Visual Training Program, Latest Edition
Tool and Manufacturing Engineers Handbook, Society of Manufacturing Engineers, Latest Edition

Lab Manual: None required

METHODS OF INSTRUCTION:

Lecture: Presentations and demonstrations.

Laboratory: Practice with coaching and close supervision.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;
2. Instructor's observation of hands-on performance;
3. Student closely following safety and shop procedures; and,
4. Student mastery of competencies.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Apply measuring skills	
Start from center line	
Apply layout skills	
Apply fabrication skills	
Understand precision measurement and "close tolerance"	
Total Lecture Hours	20

LAB OUTLINE:

Lab Topics	Contact Hrs.
See Laboratory Handbook	
Total Lab Hours	40

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

   A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*

    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
- ***B. Interpersonal:*** *Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
- ***C. Information:*** *Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
- ***D. Systems:*** *Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
- ***E. Technology:*** *Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
- A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    - ***1. Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
        - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
        - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

    c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

- f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
- g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking*****:** *Organizes ideas and communicates orally*
   - a. Demonstrates appropriate listening and speaking skills in personal conversations
   - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

- a. Demonstrates ability to objectively assess personal strengths and weaknesses
- b. Demonstrates ability to set realistic short-term and long-term goals
- c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
- d. Demonstrates ability to identify potential pitfalls and take evasive actions
- e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
- f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
- g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes
    - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    - c. Demonstrates ability to visually discriminate in gross and fine imagery
    - d. Demonstrates ability to visualize abstractly

e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*

a. Demonstrates mastery of basic reading, math, and language skills through application

b. Demonstrates ability to translate abstract theory into practical application

c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process

d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*

a. Demonstrates use of simple logic

b. Demonstrates ability to distinguish relationships

c. Demonstrates ability to determine and isolate factors in relationships

d. Demonstrates and applies knowledge through practice

e. Recognizes that attitudes, skills, and practice are essential to productivity

f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner

c. Demonstrates ability to focus on task at hand and work to completion

d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

e. Demonstrates maturity to take responsibility for actions

f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions

d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable

e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    WLD-A1 through WLD-A13;
    WLD-B1 through WLD-B5;
    WLD-C1 through WLD-C9;
    WLD-D1 through WLD-D7;
    WLD-E1 through WLD-E13;
    WLD-F1 through WLD-F6;
    WLD-G1 through WLD-G4;
    WLD-H1 through WLD-H17;
    WLD-I1 through WLD-I5;
    WLD-J1 through WLD-J4;
    WLD-K1 through WLD-K9;
    WLD-L1 through WLD-L12;
    WLD-M1 through WLD-M35;
    WLD-N1 through WLD-N4;
    WLD-O1 through WLD-O10;
    WLD-P1 through WLD-P7;
    WLD-Q1 through WLD-Q2;
    WLD-R1 through WLD-R5;
    WLD-S1 through WLD-S5;
    WLD-T1 through WLD-T3; and,
    WLD-U1 through WLD-U6.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition
5. *Hobart Audio-Visual Training Program,* Latest Edition
6. *Miller Audio-Visual Training Program,* Latest Edition

WLD-1161

MASTER PROGRAM

Pipe Welding

Course Syllabus

Total lecture hours: 20 **Total lab Hours: 40** **Credit hours: 3**

COURSE DESCRIPTION:

A course in the fundamentals of pipe welding including pipe welding terminology, oxyacetylene welding and brazing of small diameter pipe, shielded metal arc welding of large diameter pipe. Extensive use of the oxyacetylene cutting process for pipe beveling is an integral aspect of this course.

PREREQUISITES: **None**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Apply basic safety and shop skills;
2. Read blueprint and drawings;
3. Demonstrate knowledge of adequate preparation of welding surfaces;
4. Demonstrate an understanding of American Petroleum Institute (API) standards;
5. Demonstrate an understanding of American Welding Society (AWS) standards;
6. Understand how to read and apply welding procedures;
7. Identify proper applications with AC and DC welding;
8. Become proficient in shielded metal arc welding (SMAW) skills on pipe of various diameters;
9. Become proficient in oxyacetylene cutting and welding skills on pipe of various diameters;
10. Become proficient in flux core arc welding (FCAW) skills on pipe of various diameters;
11. Become proficient in gas tungsten arc welding (GTAW) on pipe; and,
12. Identify the most common problems associated with pipe welding.

REQUIRED COURSE MATERIALS:

Textbook: ***Welding Technology Today, Principles and Practices,*** Craig Stinchcomb, Publisher: Prentice Hall, Inc., New Jersey, Latest Edition

Lab Manual: Student handbook

METHODS OF INSTRUCTION:

Lecture: Presentations and demonstrations.

Laboratory: Practice with coaching and close supervision.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;
2. Instructor's observation of hands-on performance; and,
3. Student must closely follow safety and shop procedures.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Review safety procedures	
Review the use of blueprints and welding symbols	
Identify types of weld joints	
Identify welding variables relevant to the prevention of specific welding imperfections	
Identify the methods of preventing and minimizing the effects of magnetism and arc blow upon weld quality	
The use of trackers and other cutting devices	
Preparation of weld surfaces using grinders and files	
Identify gapping processes on pipe	
Properly select the correct electrodes for various steels and welding applications	
Weld pipe using 6010 and 7018 electrodes	
Guided bend test to determine weld quality	—
Total Lecture Hours	**20**

LAB OUTLINE:

Lab Topics	Contact Hrs.
See Laboratory Handbook	—
Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. ***Interpersonal:*** *Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. ***Information:*** *Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. ***Systems:*** *Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  E. ***Technology:*** *Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks

        3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

- A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    - *1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
        - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
        - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
        - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
        - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
        - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
    - *2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
        - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
        - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
        - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
        - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
        - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking**: Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate

    - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

  1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
  2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes
    - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
  - 3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    - c. Demonstrates ability to visually discriminate in gross and fine imagery
    - d. Demonstrates ability to visualize abstractly
    - e. Demonstrates ability to apply visual imagery to applied tasks
  - 4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    - a. Demonstrates mastery of basic reading, math, and language skills through application
    - b. Demonstrates ability to translate abstract theory into practical application
    - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    - d. Demonstrates knowledge of good study skills and learning habits
  - 5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    - a. Demonstrates use of simple logic
    - b. Demonstrates ability to distinguish relationships
    - c. Demonstrates ability to determine and isolate factors in relationships
    - d. Demonstrates and applies knowledge through practice
    - e. Recognizes that attitudes, skills, and practice are essential to productivity
    - f. Demonstrates ability to discriminate between positive and negative, and act accordingly
- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
  - 1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

- a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
- b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
- c. Demonstrates ability to focus on task at hand and work to completion
- d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
- e. Demonstrates maturity to take responsibility for actions
- f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks
    - b. Demonstrates ability to separate work and personal behaviors
    - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    - e. Demonstrates ability to accept and use constructive criticism
    - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    - a. Demonstrates appropriate and acceptable social behaviors in interactions
    - b. Demonstrates ability to work cooperatively in individual, team, or group situations
    - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    - a. Accepts personal strengths and weaknesses and uses the same for positive advancement

   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   - WLD-A1 through WLD-A13;
   - WLD-B1 through WLD-B5;
   - WLD-C1 through WLD-C9;
   - WLD-D1 through WLD-D7;
   - WLD-E1 through WLD-E13;
   - WLD-F1 through WLD-F6;
   - WLD-G1 through WLD-G4;
   - WLD-H1 through WLD-H17;
   - WLD-I1 through WLD-I5;
   - WLD-J1 through WLD-J4;
   - WLD-K1 through WLD-K9;
   - WLD-L1 through WLD-L12;
   - WLD-M1 through WLD-M35;
   - WLD-N1 through WLD-N4;
   - WLD-O1 through WLD-O10;
   - WLD-P1 through WLD-P7;
   - WLD-Q1 through WLD-Q2;
   - WLD-R1 through WLD-R5;
   - WLD-S1 through WLD-S5; and,
   - WLD-U1 through WLD-U6.

2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition
5. *Hobart Audio-Visual Training Program,* Latest Edition
6. *Miller Audio-Visual Training Program,* Latest Edition

WLD 1112
07/062298

SPC-2600

MASTER PROGRAM

Effective Speaking

Course Syllabus

Total lecture hours: 45 **Total lab hours: 0** **Credit hours: 3**

COURSE DESCRIPTION:

The nature and basic principles of speech, with emphasis on improving speaking and listening skills common to all forms of communication through a variety of experiences in public speaking, will include such activities as group discussions, videotaping, and student speeches to inform, to introduce, to persuade, and to commemorate special occasions.

PREREQUISITES: **Freshman Composition Skills I**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Demonstrate confidence, poise, and self assurance when speaking publicly;
2. Demonstrate clear, logic and objective thinking;
3. Communicate ideas effectively and appropriately through spoken language;
4. Develop good delivery skills;
5. Demonstrate experience speaking impromptu and extemporaneously;
6. Develop the power of imagination and creative thinking;
7. Take responsibility for leadership ethics;
8. Become a better listener;
9. Understand the thoughts and feelings of others; and,
10. Widen horizons of knowledge, including understanding of self and others.

REQUIRED COURSE MATERIALS:

Textbook: *The Art of Speaking,* Stephan E. Lucas, Publisher: Random House, Latest Edition

Lab Manual: None required

METHODS OF INSTRUCTION:

Lecture: Presentations and demonstrations.

Laboratory: None

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Speeches – 60%;
2. Exam – 15%;
3. Written work – 10%; and,
4. Participation – 15%.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Lectures on gathering materials and speaking techniques	
Class discussions on speech topics	
Example speeches live or on video	
Manuscripts of speeches for example and evaluation	
Extemporaneous speaking experiences by students	
a. Personal incident or demonstration	
b. Speech to inform	
c. Speech to persuade	
d. Speech for a special occasion	
e. Introduction of a speaker or oral interpretation	
Impromptu speaking experiences by students	
Informal speaking such as audience analysis, reporting on "real" speeches attended, response to classmates' speeches, group discussions, etc.	
Assessment of individual videos of themselves by students and/or critiques or commentary on peers' speeches	
Total Lecture Hours	**45**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part *foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."*

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. ***Resources:** Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. ***Interpersonal:** Works with others*
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   C. ***Information:** Acquires and uses information*
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   D. ***Systems:** Understands complex inter-relationships* .
      1. Understands and works well with social, organizational, and technological systems
      2. Monitors and corrects performance of system during operation
      3. Recommends modifications to system to improve performance
   E. ***Technology:** Works with a variety of technologies*
      1. Chooses relevant procedures, tools, and equipment
      2. Applies appropriate procedures and techniques to accomplish tasks
      3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
   A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    a. **Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts**
    b. **Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study**
    c. **Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)**
    d. **Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner**
    e. **Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials**
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. **Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning**
    b. **Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.**
    c. **Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered**
    d. **Demonstrates ability to complete all required writings in a timely, complete, and professional manner**
    e. **Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments**
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

        - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        - g. Demonstrates ability to take responsibility for presentations

- B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    - *1.* ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        - a. Demonstrates ability to objectively assess personal strengths and weaknesses
        - b. Demonstrates ability to set realistic short-term and long-term goals
        - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
        - d. Demonstrates ability to identify potential pitfalls and take evasive actions
        - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
        - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
        - g. Demonstrates maturity in taking responsibility for decisions
    - *2.* ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
        - a. Demonstrates ability to detect problem through observation, inquiry, or directive
        - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
        - c. Demonstrates ability to generate alternatives or options for problem solution
        - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
        - e. Demonstrates ability to initiate and effect solution
        - f. Demonstrates ability to take responsibility for outcomes

        - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
    - 3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
        - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
        - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
        - c. Demonstrates ability to visually discriminate in gross and fine imagery
        - d. Demonstrates ability to visualize abstractly
        - e. Demonstrates ability to apply visual imagery to applied tasks
    - 4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
        - a. Demonstrates mastery of basic reading, math, and language skills through application
        - b. Demonstrates ability to translate abstract theory into practical application
        - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        - d. Demonstrates knowledge of good study skills and learning habits
    - 5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        - a. Demonstrates use of simple logic
        - b. Demonstrates ability to distinguish relationships
        - c. Demonstrates ability to determine and isolate factors in relationships
        - d. Demonstrates and applies knowledge through practice
        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly
- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - 1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

- b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
- c. Demonstrates ability to focus on task at hand and work to completion
- d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
- e. Demonstrates maturity to take responsibility for actions
- f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks
    - b. Demonstrates ability to separate work and personal behaviors
    - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    - e. Demonstrates ability to accept and use constructive criticism
    - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    - a. Demonstrates appropriate and acceptable social behaviors in interactions
    - b. Demonstrates ability to work cooperatively in individual, team, or group situations
    - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    - c. Demonstrates ability to formulate and follow personal schedules

    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

HUM-1021

MASTER PROGRAM

Introduction to the Humanities

Course Syllabus

Total lecture hours: 45 **Total lab hours: 0** **Credit hours: 3**

COURSE DESCRIPTION:

An exploration of the arts, ideas, and values in western culture. This course has a minimum writing requirement of 3,000 words.

PREREQUISITES: **Freshman Composition Skills I**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Demonstrate knowledge of the major styles and schools of the arts, including: two dimensional art, especially painting; sculpture; architecture; literature; theater; music; dance; film;
2. Demonstrate knowledge of ideas (philosophical and religious) associated with the major cultural periods of western civilization;
3. Demonstrate knowledge of important artists and thinkers and their contributions to western culture;
4. Demonstrate knowledge of aesthetic and technical vocabulary used in the Humanity;
5. Demonstrate an understanding of the importance of perception and feeling in the humanities by attending a variety of cultural activities (3);
6. Demonstrate an awareness of the basic values of western society; and,
7. Demonstrate an ability to write satisfactorily a minimum of 3,000 words with accurate information, and in standard, acceptable English.

REQUIRED COURSE MATERIALS:

Textbook:	***Culture and Values, Vol II,*** Cunningham/Reich, Publisher: Harcourt, Brace, Latest Edition ***Study Guide,*** Holmes, Publisher: Harcourt, Brace, Latest Edition
Lab Manual:	None required

METHODS OF INSTRUCTION:

Lecture: Presentation and demonstration.

Laboratory: None

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests;
2. Class participation; and,
3. Compositions.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Studying and Humanities – An Introduction	
The arts (two-dimensional, sculpture, architecture, literature, music, theater, dance and film) and ideas (philosophy and religion) of the:	
a. Pre-classical World	
b. Classical World of Greece and Rome	
c. Medieval World	
d. Renaissance	
e. Baroque Age	
f. Enlightenment	
g. Nineteenth and Twentieth Centuries	
The values of Western Culture	
Total Lecture Hours	**45**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. ***Resources:** Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. ***Interpersonal:** Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. ***Information:** Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. ***Systems:** Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  E. ***Technology:** Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
  A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    1. ***Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

   - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   - c. Demonstrates ability to understand and perform multi-step computations

    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking***: *Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. Demonstrates ability to objectively assess personal strengths and weaknesses
    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    d. Demonstrates ability to identify potential pitfalls and take evasive actions
    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery

  - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
  - c. Demonstrates ability to visually discriminate in gross and fine imagery
  - d. Demonstrates ability to visualize abstractly
  - e. Demonstrates ability to apply visual imagery to applied tasks
- *4.* ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
  - a. Demonstrates mastery of basic reading, math, and language skills through application
  - b. Demonstrates ability to translate abstract theory into practical application
  - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
  - d. Demonstrates knowledge of good study skills and learning habits
- *5.* ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
  - a. Demonstrates use of simple logic
  - b. Demonstrates ability to distinguish relationships
  - c. Demonstrates ability to determine and isolate factors in relationships
  - d. Demonstrates and applies knowledge through practice
  - e. Recognizes that attitudes, skills, and practice are essential to productivity
  - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

- *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
  - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
  - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
  - c. Demonstrates ability to focus on task at hand and work to completion
  - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

   - e. Demonstrates maturity to take responsibility for actions
   - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   - a. Presents a positive attitude toward tasks
   - b. Demonstrates ability to separate work and personal behaviors
   - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors

b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

HUM 1021
07/062298

MASTER Curriculum
Welding
A.S. Degree Program

		LEC	LAB	CR
FIRST SEMESTER				
WLD 1106	Welding I	20	40	3
WLD 2122	Shielded Metal Arc Welding	20	40	3
WLD 1112	Oxyacetylene Welding	20	40	3
ENC 1101	Freshman Composition Skills I	45	0	3
MTB 1321	Technical Mathematics	45	15	3
SECOND SEMESTER				
WLD 2137	Advanced Welding I	20	40	3
WLD 1101	Blueprint Reading for Welders	30	30	3
WLD 1123	TIG (GTAW) Welding	20	40	3
ISS 1010 *or* WOH 1012 *or* WOH 1022	Introduction to the Social Sciences *or* World Civilizations I *or* World Civilizations II	45	0	3
PHY 1020	Elementary Physics for Non-Science Majors *or* Any Physical Science	45	0	3
THIRD SEMESTER				
WLD 1104	Manufacturing/Metallurgical Processes	30	30	3
HLP 1082	Wellness Applications	30	0	2
FOURTH SEMESTER				
WLD 2132	Advanced Welding II	20	40	3
WLD 2930	Welding Fabrication Techniques	20	40	3
WLD 1161	Pipe Welding	20	40	3
SPC 2600	Effective Speaking	45	0	3
HUM 1021	Introduction to the Humanities	45	0	3
FIFTH SEMESTER				
WLD 2931	Welding Design and Fabrication	20	40	3
WLD 1157	Specialty MIG and Plasma Arc Welding	15	45	3
WLD 1175	Pipe Fitting	15	45	3
	Technical Elective/Specialties	100	200	5
	Program Totals	670	725	64

WLD-2931

MASTER PROGRAM

Welding Design and Fabrication

Course Syllabus

Total lecture hours: 20 **Total lab hours: 40** **Credit hours: 3**

COURSE DESCRIPTION:

This course teaches advanced techniques in metal fabrication. Advanced layout and blueprint interpretation will be taught.

PREREQUISITES: **None**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Interpret welding symbols;
2. Interpret detail drawings;
3. List materials for fabrication from blueprints; and,
4. Develop shop drawings.

REQUIRED COURSE MATERIALS:

Textbook: *Modern Welding,* Althouse, Turnquist, Bowditch, and Bowditch, Publisher: Goodheart-Wilcox, Latest Edition

Supplemental Text Materials:

Handbook of Welding Procedures, Latest Edition
Hobart Audio-Visual Training Program, Latest Edition
American Welding Society – Competency Standards
Miller Audio-Visual Training Program, Latest Edition
Tool and Manufacturing Engineers Handbook, Society of Manufacturing Engineers, Latest Edition

Lab Manual: None required

METHODS OF INSTRUCTION:

Lecture: Presentation and demonstration.

Laboratory: Practice with coaching and close supervision.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;
2. Instructor's observation of hands-on performance;
3. Student closely following safety and shop procedures; and,
4. Student mastery of competencies.

LECTURE OUTLINE:

Lecture Topics		Contact Hrs.
The student will develop techniques in metal fabrication, layout and blueprint through various projects developed by the instructor		
When the desired level of understanding is reached, the students will then begin their own projects		
	Total Lecture Hours	**20**

LAB OUTLINE:

Lab Topics		Contact Hrs.
See Laboratory Handbook		
	Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   - A. ***Resources:** Identifies, organizes, plans, and allocates resources*
      - 1. Allocates time to complete assigned tasks on schedule

    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. *Information: Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. *Systems: Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  E. *Technology: Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
  A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    1. *Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts,

diagrams, graphs, schematics, blueprints, flow charts, etc.)

   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

- g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
   - a. Demonstrates appropriate listening and speaking skills in personal conversations
   - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   - a. Demonstrates ability to objectively assess personal strengths and weaknesses

   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:** Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. **Demonstrates mastery of basic reading, math, and language skills through application**
    b. **Demonstrates ability to translate abstract theory into practical application**
    c. **Demonstrates ability to incorporate and generalize new learning into a sequential learning process**
    d. **Demonstrates knowledge of good study skills and learning habits**
5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. **Demonstrates use of simple logic**
    b. **Demonstrates ability to distinguish relationships**
    c. **Demonstrates ability to determine and isolate factors in relationships**
    d. **Demonstrates and applies knowledge through practice**
    e. **Recognizes that attitudes, skills, and practice are essential to productivity**
    f. **Demonstrates ability to discriminate between positive and negative, and act accordingly**

C. **Personal Qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty**

1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*
    a. **Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals**
    b. **Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner**
    c. **Demonstrates ability to focus on task at hand and work to completion**
    d. **Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time**
    e. **Demonstrates maturity to take responsibility for actions**
    f. **Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner**
2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
    a. **Presents a positive attitude toward tasks**

b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. Demonstrates ability to accept and use constructive criticism
f. Accepts positive reinforcement in an appropriate manner

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    - WLD-A1 through WLD-A13;
    - WLD-B1 through WLD-B5;
    - WLD-C1 through WLD-C9;
    - WLD-D1 through WLD-D7;
    - WLD-E1 through WLD-E13;
    - WLD-F1 through WLD-F6;
    - WLD-G1 through WLD-G4;
    - WLD-H1 through WLD-H17;
    - WLD-I1 through WLD-I5;
    - WLD-J1 through WLD-J4;
    - WLD-K1 through WLD-K9;
    - WLD-L1 through WLD-L12;
    - WLD-M1 through WLD-M35;
    - WLD-N1 through WLD-N4;
    - WLD-O1 through WLD-O10;
    - WLD-P1 through WLD-P7;
    - WLD-Q1 through WLD-Q2;
    - WLD-R1 through WLD-R5;
    - WLD-S1 through WLD-S5;
    - WLD-T1 through WLD-T3; and,
    - WLD-U1 through WLD-U6.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition
5. *Hobart Audio-Visual Training Program,* Latest Edition
6. *Miller Audio-Visual Training Program,* Latest Edition

WLD-1157

MASTER PROGRAM

Specialty MIG and Plasma Arc Welding

Course Syllabus

Total lecture hours: 15 **Total lab hours: 45** **Credit hours: 3**

COURSE DESCRIPTION:

This course will cover the fundamentals of MIG welding, layout work, fabrication, and repair type welding. The student will have the opportunity to fine-tune gas, arc, TIG, and oxyacetylene cutting skills before entering the job market. This course will also cover job-seeking techniques, such as: application forms, resume writing, and interview procedures.

PREREQUISITES: None

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Increase employability skills;
2. Apply basic shop skills;
3. Demonstrate knowledge of joint design, preparation, and welding terms;
4. Demonstrate ability to interpret drawings and blueprints;
5. Demonstrate knowledge of welding symbols;
6. Demonstrate knowledge of the proper applications of welding skills;
7. Demonstrate knowledge of adequate preparation of welding surfaces;
8. Increase skill level to pass certifications tests, or welding tests offered by an employer;
9. Perform a combination of welding skills;
10. Be proficient in welding in all four basic positions utilizing MIG (GMAW) welding; and,
11. Apply plasma arc skills.

REQUIRED COURSE MATERIALS:

Textbook:	*Welding Technology Today, Principles and Practices,* Craig Stinchcomb, Publisher: Prentice Hall, Inc., New Jersey, Latest Edition
Lab Manual:	Student handbook

METHODS OF INSTRUCTION:

Lecture: Presentations and demonstrations.

Laboratory: Practice with coaching and close supervision; lab tests (coupons).

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;
2. Instructor's observation of hands-on performance; and,
3. Student closely following safety and shop procedures.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Identify safety procedures unique to this type of welding	
Run beads with MIG (GMAW) and Flux Core (FCAW) equipment	
Prepare pipe joints, butt joints, lap joints, and tee joints for welding	
Increase knowledge of current industry standards and techniques	
Identify welding symbols and increase knowledge of fabrication skills	
Select and use hand tools and measuring devices	
Weld and bend test coupons	
Identify plasma arc equipment and how to use equipment	
Weld ferrous and non-ferrous metals using MIG (GMAW) equipment	
Prepare pipe joints for welding	—
Total Lecture Hours	**15**

LAB OUTLINE:

Lab Topics	Contact Hrs.
See Laboratory Handbook	—
Total Lab Hours	**45**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   - *A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
     1. Allocates time to complete assigned tasks on schedule
     2. Determines and allocates required materials and resources for meeting objectives
     3. Evaluates skills, performance, and quality of work and provides feedback
   - *B.* ***Interpersonal:*** *Works with others*
     1. Participates as a member of the team, contributing to group effort
     2. Provides individual assistance/direction to peers as requested
     3. Determines and meets expectations
     4. Exercises leadership qualities to effectively communicate ideas and make decisions.
     5. Negotiates resources in order to accomplish objectives
     6. Works well with all members of the class
   - *C.* ***Information:*** *Acquires and uses information*
     1. Acquires and evaluates information
     2. Organizes and maintains information
     3. Interprets and communicates information
   - *D.* ***Systems:*** *Understands complex inter-relationships*
     1. Understands and works well with social, organizational, and technological systems
     2. Monitors and corrects performance of system during operation
     3. Recommends modifications to system to improve performance
   - *E.* ***Technology:*** *Works with a variety of technologies*
     1. Chooses relevant procedures, tools, and equipment
     2. Applies appropriate procedures and techniques to accomplish tasks

3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. **Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages**
    b. **Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems**
    c. **Demonstrates ability to understand and perform multi-step computations**
    d. **Demonstrates ability to read, interpret, and use standard measuring devices**
    e. **Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively**
    f. **Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance**
    g. **Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines**
4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. **Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery**
    b. **Demonstrates ability to hear, comprehend, and appropriately follow directions**
    c. **Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction**
    d. **Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately**
    e. **Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds**
    f. **Demonstrates ability and maturity to seek and receive additional individualized instruction as needed**
5. ***Speaking***: *Organizes ideas and communicates orally*
    a. **Demonstrates appropriate listening and speaking skills in personal conversations**
    b. **Demonstrates ability to choose and organize appropriate words to effectively communicate**

- c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
- d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
- e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
- f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
- g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   - a. Demonstrates ability to objectively assess personal strengths and weaknesses
   - b. Demonstrates ability to set realistic short-term and long-term goals
   - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   - d. Demonstrates ability to identify potential pitfalls and take evasive actions
   - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   - g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   - a. Demonstrates ability to detect problem through observation, inquiry, or directive
   - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   - c. Demonstrates ability to generate alternatives or options for problem solution
   - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

        e. Demonstrates ability to initiate and effect solution
        f. Demonstrates ability to take responsibility for outcomes
        g. Demonstrates ability to effectively problem solve in individual, team, or group situations

    3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
        a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
        b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
        c. Demonstrates ability to visually discriminate in gross and fine imagery
        d. Demonstrates ability to visualize abstractly
        e. Demonstrates ability to apply visual imagery to applied tasks

    4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
        a. Demonstrates mastery of basic reading, math, and language skills through application
        b. Demonstrates ability to translate abstract theory into practical application
        c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        d. Demonstrates knowledge of good study skills and learning habits

    5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        a. Demonstrates use of simple logic
        b. Demonstrates ability to distinguish relationships
        c. Demonstrates ability to determine and isolate factors in relationships
        d. Demonstrates and applies knowledge through practice
        e. Recognizes that attitudes, skills, and practice are essential to productivity
        f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

    1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

   - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   - c. Demonstrates ability to focus on task at hand and work to completion
   - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   - e. Demonstrates maturity to take responsibility for actions
   - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   - a. Presents a positive attitude toward tasks
   - b. Demonstrates ability to separate work and personal behaviors
   - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement

  - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
  - c. Demonstrates ability to formulate and follow personal schedules
  - d. Demonstrates ability to wisely use classroom time
  - e. Demonstrates use of good study habits and skills
  - f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
  - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
  - b. Demonstrates honesty and integrity in working with peers and supervisors
  - c. Takes full responsibility for personal actions
  - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
  - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   WLD-A1 through WLD-A13;
   WLD-B1 through WLD-B5;
   WLD-C1 through WLD-C9;
   WLD-D1 through WLD-D7;
   WLD-E1 through WLD-E13;
   WLD-F1 through WLD-F6;
   WLD-G1 through WLD-G4;
   WLD-H1 through WLD-H17;
   WLD-I1 through WLD-I5;
   WLD-J1 through WLD-J4;
   WLD-K1 through WLD-K9;
   WLD-L1 through WLD-L12;
   WLD-M1 through WLD-M35;
   WLD-N1 through WLD-N4;
   WLD-O1 through WLD-O10;
   WLD-P1 through WLD-P7;
   WLD-Q1 through WLD-Q2;
   WLD-R1 through WLD-R5;
   WLD-S1 through WLD-S5;
   WLD-T1 through WLD-T3; and,

WLD-U1 through WLD-U6.

2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition
5. *Hobart Audio-Visual Training Program,* Latest Edition
6. *Miller Audio-Visual Training Program,* Latest Edition

WLD 1167
07/062298

MASTER PROGRAM

Pipe Fitting

Course Syllabus

Total lecture hours: 15 **Total lab hours: 45** **Credit hours: 3**

COURSE DESCRIPTION:

This course will cover the fit up and welding of all common pipe configurations such as branches, laterals, headers and reducers. Extensive use of the shielded metal arc welding and the oxyacetylene cutting processes are an integral aspect of this course.

PREREQUISITES: **None**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Enhance the ability to interpret blueprints and drawings;
2. Use common squaring and working point methods;
3. Compare preparation and welding processes for cost efficiency and time;
4. Accurately lay out and cut slopes and rolling tolerances on various structural shapes using a framing square, ruler, protractor, lamps and level;
5. Identify error possibilities;
6. Determine materials needed to produce the part;
7. Determine quantities needed to produce the part;
8. Prepare joint geometry using oxy fuel; and,
9. Identify methods of minimizing effects of high pressure and heat on the life of piping systems.

REQUIRED COURSE MATERIALS:

Textbook:	*Welding Technology Today, Principles and Practices,* Craig Stinchcomb, Publisher: Prentice Hall, Inc., New Jersey, Latest Edition
Lab Manual:	Student handbook

METHODS OF INSTRUCTION:

Lecture: Presentations and demonstrations.

Laboratory: Practice with coaching and close supervision.

Method of Evaluation: A student's grade will be based on multiple measures of performance, including:

1. Tests and quizzes administered throughout the term;
2. Instructor's observation of hands-on performance; and,
3. Student closely following safety and shop procedures.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Define the following: precision, reliability and accuracy	
Demonstrate general measurement techniques	
Demonstrate semi-precision measurement techniques	
Document results of measurement activities and calculations	
Match appropriate measurement tools with various types of measurement requirements	
Demonstrate proper measurement tool usage	
List steps of proper measurement	
Explain rationale for each step	
Discriminate between accepted measurement procedures and improper measurement procedures	
Illustrate measurement differences with calibrated and non-calibrated instruments	
Properly lay out and cut pipe using illustrated bevel	
Total Lecture Hours	15

LAB OUTLINE:

Lab Topics	Contact Hrs.
See Laboratory Handbook	
Total Lab Hours	45

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should *develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."*

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   - A. ***Resources:** Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   - B. ***Interpersonal:** Works with others*
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   - C. ***Information:** Acquires and uses information*
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   - D. ***Systems:** Understands complex inter-relationships*
      1. Understands and works well with social, organizational, and technological systems
      2. Monitors and corrects performance of system during operation
      3. Recommends modifications to system to improve performance
   - E. ***Technology:** Works with a variety of technologies*
      1. Chooses relevant procedures, tools, and equipment
      2. Applies appropriate procedures and techniques to accomplish tasks
      3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

    d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. Demonstrates ability to objectively assess personal strengths and weaknesses
    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    d. Demonstrates ability to identify potential pitfalls and take evasive actions
    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes

    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
  3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    c. Demonstrates ability to visually discriminate in gross and fine imagery
    d. Demonstrates ability to visualize abstractly
    e. Demonstrates ability to apply visual imagery to applied tasks
  4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
  5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
  1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

- b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
- c. Demonstrates ability to focus on task at hand and work to completion
- d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
- e. Demonstrates maturity to take responsibility for actions
- f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   - a. Presents a positive attitude toward tasks
   - b. Demonstrates ability to separate work and personal behaviors
   - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules

d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    WLD-A1 through WLD-A13;
    WLD-B1 through WLD-B5;
    WLD-C1 through WLD-C9;
    WLD-D1 through WLD-D7;
    WLD-E1 through WLD-E13;
    WLD-F1 through WLD-F6;
    WLD-G1 through WLD-G4;
    WLD-H1 through WLD-H17;
    WLD-I1 through WLD-I5;
    WLD-J1 through WLD-J4;
    WLD-K1 through WLD-K9;
    WLD-L1 through WLD-L12;
    WLD-M1 through WLD-M35;
    WLD-N1 through WLD-N4;
    WLD-O1 through WLD-O10;
    WLD-P1 through WLD-P7;
    WLD-Q1 through WLD-Q2;
    WLD-R1 through WLD-R5;
    WLD-S1 through WLD-S5; and,
    WLD-U1 through WLD-U6.
2. *Machinery's Handbook,* Industrial Press, Latest Edition
3. *Welding Technology Today, Principles and Practices,* Stinchcomb, Craig; Prentice Hall Inc., New Jersey, Latest Edition
4. *Welder Handbook,* (W-100) E-1 Corp., Publication # 51077, Latest Edition
5. *Hobart Audio-Visual Training Program,* Latest Edition

6. *Miller Audio-Visual Training Program,* Latest Edition

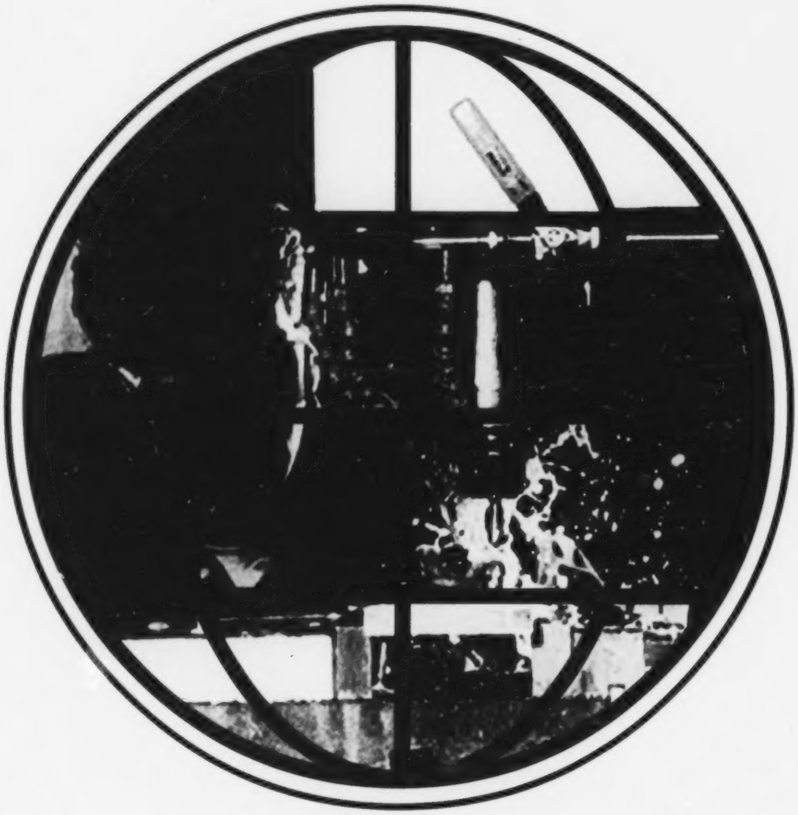
WLD 1175
07/062298

MASTER

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY



Welding Series
INSTRUCTOR'S HANDBOOK
DUTIES A THROUGH J

Supported by the National Science Foundation's Advanced Technological Education Program

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Welding Series
INSTRUCTOR'S HANDBOOK

Supported by the National Science Foundation's Advanced Technological Education Program

This material is based upon work supported by the
National Science Foundation under Grant No. DUE-9553716

National Science Foundation
Advanced Technological
Education Program

"Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Foundation."

ACKNOWLEDGEMENTS

This project was made possible by the cooperation and direct support of the following organizations:

National Science Foundation - Division of Undergraduate Education
MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS

Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES

AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES

Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS

Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS

Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER
Central Florida Community College

Central Florida Community College

Dr. Charles R. Dessance, President

Dr. Hugh Rogers, Project Administrator

P.O. Box 1388
Ocala, FL 34478-1388
College phone: 352-873-5823
fax: 352-873-5883
Center phone: 407-384-2155

Manufacturing in Florida

During the past two decades, the Central Florida region near Florida's Space Coast, Melbourne, Cape Canaveral, Coala, Orlando, and the I-4 corridor to Tampa has experienced unprecedented economic growth. This growth has been especially evident in the fields of aerospace, electronics, laser electro-optics, and simulation enterprises. From 1990 to 1997 the area's population grew by more than 13 percent to approximately 4 million.

Manufacturing companies in the region now number more than 3000. The products manufactured range from aerospace to space launch equipment, advanced technology emergency vehicles, to sophisticated electronic and simulation components, circuit boards, laser equipment, wireless data systems, communication devices, and metals fabrication. Much of the nation's aerospace, satellite, and space facilities are concentrated in the region, including NASA, Lockheed Martin, E.G. and G. Inc., Boeing, McDonnell Douglas, Rockwell, Raytheon, Grumman, and Harris Corporation. Electronic companies such as Siemens, AT&T, Lucent, and Motorola serve both U.S. and export markets.

Central Florida, with three interstate highways (I-95, I-4, and I-75), is home to the University of Central Florida, its 27,000 students, and programs which include comprehensive engineering and engineering technology. Central Florida's growth has helped to fuel the State of Florida's growth to fourth largest state in the U.S. with a population of 14.6 million. By 2010 the state's population is projected to increase by more than 13 percent with 9 percent of its total workforce involved in manufacturing.

Central Florida Community College

Central Florida Community College (CFCC), serving a total of 6,000 students, offers a center of emphasis in Electronics, a Manufacturing Technology program with an internship requirement, an Industrial Maintenance/Machining program, a CADD program, and a Computer Design/Application program. Ocala, home of the college, has rapidly become an industrial center, with Lockheed Martin's Microelectronics Circuit Board Facility, and a second plant for Defense/Commercial Satellite Communications Manufacturing. E-One Corporation and other companies contribute to 17 percent of the local workforce being engaged in manufacturing.

Development Team

- **Project Coordinator**: Dr. Hugh Rogers, former Dean of Technical Education; served as the primary administrator and academic coordinator for the MASTER project. He also conducted the occupational skills profile interviews and benchmarked the welding instructional modules with review at four other colleges: Moraine Valley (Palos Hills, IL), IVY Tech (Terra Haute, Ind), Macomb Community College (Sterling Heights, MI), and Henry Ford Community College (Dearborn, MI).
- **Subject Matter** Experts: Mr Bill Rhodes and Mr Doug Wilson were responsible for developing skill standards and course/program materials for the welding technology components of the MASTER project. Other colleges and the American Welding Society.

Introduction:
INSTRUCTOR'S HANDBOOK

Prior to the development of this Instructor's Handbook, **MASTER** project staff visited over 150 companies, conducted interviews with over 500 expert workers, and analyzed data from a national survey involving over 2800 participating companies. These investigations led to the development of a series of Instructor Handbooks, with each being fully industry-driven and specific to one of the technologies shown below.

Advanced CNC and CAM
Automated Equipment Repair
Computer Aided Design & Drafting
Conventional Machining
Industrial Maintenance
Instrumentation
LASER Machining
Manufacturing Technology
Mold Making
Tool And Die
Welding

Each Instructor's Handbook contains a collection of Technical Training Modules which are built around a Competency Profile for the specific occupation. **The Competency Profile which is the basis for this Instructor's Handbook, may be found on the following page (and on each of the tab pages of this book).**

Each Technical Training Module has been designed to be:

* Based on skill standards specified by industry. There must be a direct correlation between what industry needs and what is taught in the classroom and in the laboratory. For many years this type of training has been known as "competency-based training".

* Generic in nature. The training materials may then be customized by the trainer, for any given training situation based on the training need.

* Modular in design, to allow trainers to select lessons which are applicable to their training needs.

* Comprehensive, include training for advanced and emerging, highly-specialized manufacturing technologies.

- Self-contained, including all the components which might be needed by an experienced trainer. These components might include any or all of the following:
  - a standardized lesson plan,
  - an assessment instrument,
  - a listing of commercially available resources (e.g. recommended textbooks, instructor guides, student manuals, and videos),
  - new training materials, when suitable existing materials are not available (e.g., classroom handouts, transparency masters, and laboratory exercises).

This Instructor's Handbook is arranged by Duty groupings (Duty A, Duty B, etc.) with technical modules developed for each Task Box on the Competency Profile. Trainers are free to choose modules for a specific training need and combine modules to build individualized training programs.

This Instructor's Handbook is being offered with an accompanying Student Laboratory Manual for use by the students enrolled in the training program.

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

	Duties	Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Interconvert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test weld to verify parameters								

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		← Tasks →												
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 Perform GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Preheat joint, if required; understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel & stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											

WLD FM9
07/1996

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties ← **Tasks** →

P	**Plasma Arc Cutting and Welding**	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	**In-Process Weld Inspection**	Q-1 Check weld size	Q-2 Perform visual inspection											
R	**In-Process Rework**	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	**Housekeeping Activities**	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	**Emergency Vehicle Terminology**	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	**Wellness/ Physical Abilities**	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	[illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDs.PM5
072996

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat, horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES
MASTER Technical Module No. WLD-A01

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **FOLLOW SAFETY PRACTICES**
- **TASK:** Demonstrate Understanding of Safety Rules

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify safety rules;
B. Describe specific requirements for safety in welding operations;
C. Identify reference resources for welding safety information;
D. Discuss common ability to follow safety practices;
E. Demonstrate ability to follow safety practices; and,
F. Conduct a safety inspection of student work area.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-A1-HO)
MASTER Laboratory Exercise (WLD-A1-LE)
MASTER Laboratory Aid (WLD-A1-LA)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition

Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

All students must prepare themselves to enhance their attitudes toward safety. Such preparation may begin by the students asking themselves the following basic questions daily:

1. Is my hair properly stowed and secured to prevent accidents?
2. Am I wearing any jewelry?
3. Do I have the proper shoes?
4. Do I have my eye shields or safety glasses required for the job?
5. Is my work area free of debris and clean?
6. Does my machine have all its safeguards?
7. Is my machine working properly?
8. Is there any leaking cases or fire hazards?
9. Do I know where the nearest fire extinguisher is located?
10. Is my workplace properly ventilated?
11. Do I need ear protection from noise or sparks?

INTRODUCTION:

Module A1 is part of the welding series. It introduces the topic of safety, the first and primary consideration in all welding operations.

PRESENTATION OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. A lecture on safety and the hazards found when working in environments involving power equipment, high temperatures, high voltage electricity, combustible gases, high ventilation requirements, sparks and high intensity light from metal arcs.
2. A demonstration of safe practices in the welding lab.

PRACTICAL APPLICATION:

The student is best prepared when forewarned of the dangers he or she faces when completing a competency based performance of tasks in a hazardous environment. This is the practical application of each module within the duty of "Follow Safety Practices."

EVALUATION AND/OR VERIFICATION:

At the conclusion of this module, written examination(s) or competency testing will be given to determine student progress.

SUMMARY:

This module introduces the student to the most important consideration in accomplishing every welding task, safety. SAFETY COMES FIRST.

NEXT LESSON ASSIGNMENT:

Read: Welding, Cutting, and Brazing: Avoiding the 'Triple Threat', in
Keller's Official OSHA Safety Handbook, Latest Edition.

MASTER Technical Module (WLD-A2) dealing with assuming personal safety standards for self and others.

WLD-A1-HO
Demonstrate Understanding of Safety Rules
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify safety rules;
B. Describe specific requirements for safety in welding operations;
C. Identify reference resources for welding safety information;
D. Discuss common ability to follow safety practices;
E. Demonstrate ability to follow safety practices; and,
F. Conduct a safety inspection of student work area.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. A lecture on safety and the hazards found when working in environments involving power equipment, high temperatures, high voltage electricity, combustible gases, high ventilation requirements, sparks and high intensity light from metal arcs.
2. A demonstration of safe practices in the welding lab.

WLD-A1-LE

Demonstrate Understanding of Safety Rules

Attachment 2: **MASTER** Laboratory Exercise

The purpose of this exercise is to learn to recognize hazards in the workplace. Many of the hazards which you will find are common safety practices by people who simply no longer see the danger.

The instructor will guide all students through the shop and welding facilities. Each student should write down, in the space provided on the form, as many safety hazards as are found.

It should be remembered that anyone can cause a hazard merely by failing to "see the mop bucket that sits in front of the fire exit" or "the hoses that are left on the floor". Such tunnel vision is the result of familiarity and demonstrates the importance of keeping a fresh perspective every day.

Due to the nature of this laboratory exercise, no universal answer key is presented.

Safety Hazards

Type	Location	Description

WLD-A1-LA
Demonstrate Understanding of Safety Rules
Attachment 3: **MASTER** Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated
2. Do not talk to anyone who is operating a machine, except in an emergency
3. Walk only in the designated traffic lanes
4. Dress appropriately; at the absolute minimum, you must have:
   a) No loose clothing, including ties;
   b) Long hair properly stowed and secured;
   c) No jewelry;
   d) Hard, closed-toe shoes;
   e) Eye protection (safety glasses); and
   f) Ear protection (plugs or headset).
5. Follow all institutional safety rules

Name: ________________________________ Date: ______________________

WLD-A1
Demonstrate Understanding of Safety Rules
Self-Assessment

Circle the best answer.

1. A positive attitude towards safety
   a. is the responsibility of the individual
   b. is the responsibility of management
   c. can be developed by all workers, regardless of their work
   d. all of the above
   e. none of the above

2. When is jewelry permitted to be worn?
   a. on slow moving machinery
   b. if all guards are in place
   c. never
   d. if your supervisor knows
   e. none of the above

3. Most accidents occur because
   a. almost every tool is unsafe
   b. there is an unsafe condition and an unsafe action
   c. workers lack motivation
   d. there is a practical joker in every plant
   e. none of the above

4. Who is responsible for safety on the job?
   a. management and employees
   b. employees
   c. union
   d. government
   e. none of the above

5. Your most important motivation for working safely is to
   a. get a raise
   b. avoid being suspended
   c. protect yourself
   d. avoid working too hard
   e. none of the above

6. Your best protection against accidents is often
   a. alertness
   b. union policy
   c. close supervision
   d. buddy system
   e. none of the above

7. Which of the following three things is more important than natural skill in doing a job well and safely?
   a. training
   b. attitude
   c. alertness
   d. all of the above
   e. none of the above

8. When you spot something dangerous in your plant, the first thing you should do is
   a. notify OSHA
   b. report it to your supervisor
   c. note it in the company safety log
   d. walk off the job
   e. none of the above

9. OSHA regulations state that machines or equipment are safe after they are
   a. locked or tagged out
   b. turned off
   c. assumed de-energized
   d. written in the maintenance log
   e. none of the above

10. Before operating machines, the operators should
    a. ask a co-worker
    b. operate them until they learn how
    c. read all the operating manuals
    d. wear gloves
    e. none of the above

WLD-A1
Demonstrate Understanding of Safety Rules
Self-Assessment Answer Key

1. d
2. c
3. b
4. a
5. c
6. a
7. d
8. b
9. a
10. c

WELDER SERIES

MASTER Technical Module No. WLD-A02

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **FOLLOW SAFETY PRACTICES**
- **TASK:** Assume Personal Safety Standards for Self and Others

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify protective equipment and clothing;
B. Identify the location of others in coordination with the work performed;
C. Identify personal safety hazards of welding operations;
D. Discuss OSHA regulations concerning welding operations;
E. Explain the need for personal responsibility when working;
F. Operate exhaust system;
G. Shield others from "Arc Flash"; and,
H. Discuss the meaning and use of safety signs and symbols.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-A2-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual

OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

HANDOUT:

Safety Signs and Symbols Found in Welding Shops. (To be prepared by instructor for specific lab sites.)

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-A1 "Demonstrate Understanding of Safety Rules"

INTRODUCTION:

Module A2 of the course Welder, Entry Level, outlines the safety responsibility of each individual welder.

The course introduction will include:

- An overview of a fast growing technical field with many employment opportunities;
- A class demonstration of effective safety techniques; and,
- A discussion on the importance of personal responsibility for safety.

PRESENTATION OUTLINE:

I. Assume Responsibility for the Personal Safety of Oneself and Others
  A. Safety is a way of life, not an option
  B. Always operate with alertness and safety foremost in mind
II. Develop a Personal Attitude Towards Safety
  A. The key to safety is individual safety
  B. Everyone must develop a safe attitude
  C. Each step of the operation must be carefully planned
III. Interpret Safety Manual Directives
  A. Read and understand safety manual
  B. Read machine operation instructions
IV. Comply with Established Safety Practices
  A. Personal safety
    1. Body: body must be protected from burns, cuts, and bruises
    2. Proper lifting technique
      a. Personal lifting
        1) Lift with the legs, not the back
        2) Proper physical position while lifting
        3) Proper clearance for carrying

            4) "Buddy system" for heavy lifting
        b. Equipment lifting
            1) Checking ratings for lifting devices
            2) Checking lifting points on lifted item
            3) Overhead clearance requirements
            4) Static lifting devices (slings, jack stands) should be used instead of moving lifting devices (jacks or forklifts) for actually holding heavy items up while working on them
    B. Eyes: always wear safety glasses
    C. Head: keep long hair up; wear hard hat whenever required
    D. Ears: wear protection to prevent damage from noise
    E. Jewelry: no rings, watches, bracelets, necklaces (they can get caught in machinery and they are conductors of electricity)
    F. Clothing: keep sleeves and pant legs rolled down; and ties, strings, and belts away from moving parts
    G. No horse-play
    H. Do not talk to someone while that person is operating a welding machine (unless for safety reasons)
    I. Do not talk to someone while you are operating a welding machine (unless for safety reasons)
V. Identify and Control Common Machine Shop Hazards
    A. Chip formation
    B. Moving machine parts
    C. Spills and other debris
    D. Electrical lines
    E. Hydraulic and pneumatic lines
VI. Cover specific safety policies of the company

PRACTICAL APPLICATION:

The class safety pledge, a copy of which is signed and carried by each student, provides a constant reference point for safety in the learning process and the student's future work role as a successful welder.

EVALUATION AND/OR VERIFICATION:

At the conclusion of this module, written examination(s) or competency testing will be given to determine student progress.

SUMMARY:

This module establishes the personal responsibility of each student to understand and follow safety rules and practices, both as a student and as a successful working welder.

NEXT LESSON ASSIGNMENT:

Read: Personal Protective Equipment in, ***Keller's Official OSHA Safety Handbook***, Latest Edition

MASTER Technical Module (WLD-A3) dealing with describing the purpose and use of protective equipment.

WLD-A2-HO
Assume Personal Safety Standards for Self and Others
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- A. Identify protective equipment and clothing;
- B. Identify the location of others in coordination with the work performed;
- C. Identify personal safety hazards of welding operations;
- D. Discuss OSHA regulations concerning welding operations;
- E. Explain the need for personal responsibility when working;
- F. Operate exhaust system;
- G. Shield others from "Arc Flash"; and,
- H. Discuss the meaning and use of safety signs and symbols.

MODULE OUTLINE:

- I. Assume Responsibility for the Personal Safety of Oneself and Others
  - A. Safety is a way of life, not an option
  - B. Always operate with alertness and safety foremost in mind
- II. Develop a Personal Attitude Towards Safety
  - A. The key to safety is individual safety
  - B. Everyone must develop a safe attitude
  - C. Each step of the operation must be carefully planned
- III. Interpret Safety Manual Directives
  - A. Read and understand safety manual
  - B. Read machine operation instructions
- IV. Comply with Established Safety Practices
  - A. Personal safety
    - 1. Body: body must be protected from burns, cuts, and bruises
    - 2. Proper lifting technique
      - a. Personal lifting
        - 1) Lift with the legs, not the back
        - 2) Proper physical position while lifting
        - 3) Proper clearance for carrying
        - 4) "Buddy system" for heavy lifting
      - b. Equipment lifting
        - 1) Checking ratings for lifting devices
        - 2) Checking lifting points on lifted item
        - 3) Overhead clearance requirements
        - 4) Static lifting devices (slings, jack stands) should be used instead of moving lifting devices (jacks or forklifts) for actually holding heavy items up while working on them
  - B. Eyes: always wear safety glasses

- C. Head: keep long hair up; wear hard hat whenever required
- D. Ears: wear protection to prevent damage from noise
- E. Jewelry: no rings, watches, bracelets, necklaces (they can get caught in machinery and they are conductors of electricity)
- F. Clothing: keep sleeves and pant legs rolled down; and ties, strings, and belts away from moving parts
- G. No horse-play
- H. Do not talk to someone while that person is operating a welding machine (unless for safety reasons)
- I. Do not talk to someone while you are operating a welding machine (unless for safety reasons)

V. Identify and Control Common Machine Shop Hazards
- A. Chip formation
- B. Moving machine parts
- C. Spills and other debris
- D. Electrical lines
- E. Hydraulic and pneumatic lines

VI. Cover specific safety policies of the company

WELDER SERIES

MASTER Technical Module No. WLD-A03

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **FOLLOW SAFETY PRACTICES**
- **TASK:** Describe the Purpose and Use of Protective Equipment

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify safety issues unique to each type of welding;
B. Describe the protective equipment used in welding operations;
C. Explain the hazards which demand the use of protective equipment; and,
D. Demonstrate the proper use and care of protective equipment.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-A3-HO1)
MASTER Handout No. 2 (WLD-A3-HO2)
MASTER Laboratory Aid (WLD-A3-LA)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-A1	"Demonstrate Understanding of Safety Rules"
WLD-A2	"Assume Personal Safety Standards for Self and Others"

INTRODUCTION:

This is Module A3 of the course Welder, Entry Level, which introduces the student to protective equipment used in welding.

PRESENTATION OUTLINE:

I. Wear Protective Safety Clothing as Required
  A. Different types of safety clothing
    1. Protection from debris, cuts, and blows
      a. Hard hat, safety glasses or goggles, work gloves when necessary
      b. Sturdy footwear
      c. Long sleeved shirt (sleeves rolled down and buttoned)
    2. Fire-retardant and fire-resistant clothing
      a. Long sleeved, 100% cotton shirt
      b. Long pants, 100% cotton
      c. Leather chest protector, sleeves
    3. Optical filters to protect vision from intense light
      a. Welding hood or goggles
      b. Safety glasses or goggles for grinding
      c. Tinted goggles for cutting torch work
    4. Breathing protection
      a. Mask for dust, lint, smoke
  B. Function and use of safety clothing
    1. Man made fiber clothing melts to worker's skin when ignited
    2. Prevents cuts and abrasions
    3. Keep shirt sleeves rolled down (hangs on equipment)
    4. Do not cuff pant legs (causes tripping)
    5. Do not wear jewelry
      a. Catches in moving parts
      b. Conducts electricity
    6. Do not wear neckties around moving parts of machinery
    7. Keep belts and apron strings tied and away from moving equipment
II. Maintain and Use Protective Guards and Equipment on Machinery
  A. Purposes of various guards

    - 1. Do not operate a machine until guards are in place
    - 2. Stop the machine to make adjustments or repairs
    - 3. Disconnect power before removing guards or panels
  - B. Evaluation and maintenance of protective equipment
    - 1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
    - 2. Do not use defective equipment
    - 3. Report defective or unsafe equipment immediately
    - 4. Make sure equipment is properly grounded
- III. Locate and Properly Use Signs, Devices, and Barriers
  - A. Install Safety Barriers
  - B. Use caution signs
  - C. Install lock and tag devices
  - D. Know where fire extinguishers are and how to use them
- IV. Use Lifting Aids When Necessary
  - A. Discuss recommended limits on single-person lifting
  - B. Discuss proper lifting methods (use of the legs)
    - 1. Use your legs (bend your knees)
    - 2. Keep the load close to your body
    - 3. Don't twist your body while lifting
    - 4. Make sure you can see where you are going
    - 5. Wear support belts
  - C. Discuss team-lifting
    - 1. Keep load the same height while lifting
    - 2. Move and lift on command
    - 3. Use dolly, wheelbarrow, or forklift
  - D. Determine lifting ratings of lifting equipment
    - 1. Know how your forklift operates
    - 2. Understand load characteristics (weight, size, shape)
  - E. Determine holding ratings of static lifting devices
  - F. Evaluate positions on the workpiece for placement of lifting and holding devices

---

PRACTICAL APPLICATION:

The student is best prepared when forewarned of the dangers he or she faces when completing a competency based performance of tasks in a hazardous environment. This is the practical application of each module within the duty; Follow Safety Practices.

EVALUATION AND/OR VERIFICATION:

At the conclusion of this module, written examination(s) or competency testing will be given to determine student progress.

SUMMARY:

This module identifies the protective equipment recommended for use to protect all persons in welding or other hazardous environments from injury or death in accordance with OSHA standards.

NEXT LESSON ASSIGNMENT:

Read: How to Survive an Accident Involving Hazardous Materials from
The American Red Cross First Aid & Safety Handbook, Latest Edition.

MASTER Technical Module (WLD-A4) dealing with demonstrating proper handling of hazardous materials.

WLD-A3-HO1

Describe the Purpose and Use of Protective Equipment

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify safety issues unique to each type of welding;
B. Describe the protective equipment used in welding operations;
C. Explain the hazards which demand the use of protective equipment; and,
D. Demonstrate the proper use and care of protective equipment.

MODULE OUTLINE:

I. Wear Protective Safety Clothing as Required
    A. Different types of safety clothing
        1. Protection from debris, cuts, and blows
            a. Hard hat, safety glasses or goggles, work gloves when necessary
            b. Sturdy footwear
            c. Long sleeved shirt (sleeves rolled down and buttoned)
        2. Fire-retardant and fire-resistant clothing
            a. Long sleeved, 100% cotton shirt
            b. Long pants, 100% cotton
            c. Leather chest protector, sleeves
        3. Optical filters to protect vision from intense light
            a. Welding hood or goggles
            b. Safety glasses or goggles for grinding
            c. Tinted goggles for cutting torch work
        4. Breathing protection
            a. Mask for dust, lint, smoke
    B. Function and use of safety clothing
        1. Man made fiber clothing melts to worker's skin when ignited
        2. Prevents cuts and abrasions
        3. Keep shirt sleeves rolled down (hangs on equipment)
        4. Do not cuff pant legs (causes tripping)
        5. Do not wear jewelry
            a. Catches in moving parts
            b. Conducts electricity
        6. Do not wear neckties around moving parts of machinery
        7. Keep belts and apron strings tied and away from moving equipment
II. Maintain and Use Protective Guards and Equipment on Machinery
    A. Purposes of various guards
        1. Do not operate a machine until guards are in place
        2. Stop the machine to make adjustments or repairs

        3. Disconnect power before removing guards or panels
    - B. Evaluation and maintenance of protective equipment
        1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
        2. Do not use defective equipment
        3. Report defective or unsafe equipment immediately
        4. Make sure equipment is properly grounded

- III. Locate and Properly Use Signs, Devices, and Barriers
    - A. Install Safety Barriers
    - B. Use caution signs
    - C. Install lock and tag devices
    - D. Know where fire extinguishers are and how to use them
- IV. Use Lifting Aids When Necessary
    - A. Discuss recommended limits on single-person lifting
    - B. Discuss proper lifting methods (use of the legs)
        1. Use your legs (bend your knees)
        2. Keep the load close to your body
        3. Don't twist your body while lifting
        4. Make sure you can see where you are going
        5. Wear support belts
    - C. Discuss team-lifting
        1. Keep load the same height while lifting
        2. Move and lift on command
        3. Use dolly, wheelbarrow, or forklift
    - D. Determine lifting ratings of lifting equipment
        1. Know how your forklift operates
        2. Understand load characteristics (weight, size, shape)
    - E. Determine holding ratings of static lifting devices
    - F. Evaluate positions on the workpiece for placement of lifting and holding devices

WLD-A3-HO2
Describe the Purpose and Use of Protective Equipment
Attachment 2: **MASTER** Handout No. 2

The instructor will display as much protective equipment, such as welding masks, breathers, and hard hats as is practical and desirable. The instructor should demonstrate the proper use of this equipment.

WLD-A3-LA
Describe the Purpose and Use of Protective Equipment
Attachment 3: **MASTER** Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated
2. Do not talk to anyone who is operating a machine
3. Walk only in the designated traffic lanes
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules

WELDER SERIES

MASTER Technical Module No. WLD-A04

SUBJECT: WELDING TECHNICIAN **TIME: 2 HOURS**

- **DUTY:** **FOLLOW SAFETY PRACTICES**
- **TASK:** Demonstrate Proper Handling Of Hazardous Materials

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Use material safety data sheet (MSDS).
B. Identify signs and symbols on hazardous materials used in welding.
C. Discuss safety precautions to be observed with chemical hazards.
D. Discuss safety precautions to be observed welding gas hazards.
E. Demonstrate safe handling of hazardous materials in a work site.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-A4-HO)
MASTER Laboratory Aid (WLD-A4-LA)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest

Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

HANDOUT:

An atlas of safety signs and symbols used in welding. (To be prepared by the instructor for each lab.)

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-A1	"Demonstrate Understanding of Safety Rules"
WLD-A2	"Assume Personal Safety Standards for Self and Others"
WLD-A3	"Describe the Purpose and Use of Protective Equipment"

INTRODUCTION:

This is Module A4 of the program for welders. It deals with use and handling of hazardous materials.

PRESENTATION OUTLINE:

I. Define Hazardous Materials According to the EPA
    A. What makes a material hazardous?
        1. It is hazardous if it causes harm to people or environment
II. Identify Hazardous Materials
    A. Material Safety Data Sheets (MSDS)
        1. Companies that make and distribute hazardous substances must provide your company with a MSDS on hazardous material
        2. MSDS developed by OSHA
        3. MSDS is part of the Hazard Communication Standard or Right to Know regulation
        4. MSDS is an easy reference for information on hazardous substances
    B. Information in MSDS
        1. What it is
        2. Who makes or sells it
        3. Where they are located
        4. Why it is hazardous
        5. How you can be exposed to the hazard
        6. Conditions that could increase the hazard
        7. How to handle the substance safely
        8. Protection to use while working with it
        9. What to do if exposed
        10. What to do if there is a spill or emergency
III. Know the Chemical and Physical Characteristics

- A. Corrosive
    - 1. Burns skin or eyes on contact
- B. Explosive
- C. Flammable
    - 1. Catches fire easily
- D. Radioactive
- E. Reactive
    - 1. Burns, explodes
    - 2. Releases toxic vapors
- F. Toxic
    - 1. Causes illness or possibly death

IV. Describe Storage, Transportation, Disposal

- A. Resource Conservation and Recovery Act (RCRA)
    - 1. Designed to reduce hazards of waste by tracking and regulating the substance
    - 2. Method used is called from cradle (creation) to grave (disposal)
    - 3. Tells what hazards are and how to keep track of them
    - 4. Sets up rules for handling wastes
    - 5. Provides strict documentation system to track them
- B. Your employer may have to report to the Environmental Protection Agency (EPA) on how the company is meeting the RCRA responsibilities
- C. The law requires companies that treat, store, or dispose of hazardous wastes to:
    - 1. Have a permit
    - 2. Identify and analyze new hazardous waste
    - 3. Provide a secure facility that keeps unauthorized people out
    - 4. Inspect the facility regularly
    - 5. Have a contingency plan for fire, explosion, and spills
    - 6. Practice emergency response for fire, explosion, spills
    - 7. Provide proper protective clothing and equipment
    - 8. Maintain EPA-required records

PRACTICAL APPLICATION:

The student is best prepared when forewarned of the dangers he or she faces when completing a competency based performance of tasks in a hazardous environment. This is the practical application of each module within the duty; Follow Safety Practices.

EVALUATION AND/OR VERIFICATION:

At the conclusion of this module, written examination(s) or competency testing will be given to determine student progress.

SUMMARY:

This module identifies the hazardous materials to be used in welding and distinguishes between them. It identifies explosive hazards, potential air contaminants, corrosives, and poisonous substances.

NEXT LESSON ASSIGNMENT:

Read: Lockout/Tagout: The Control of Hazardous Energy in ***Keller's Official OSHA Safety Handbook***, Latest Edition.

Part 2: First Aid in ***The American Red Cross First Aid & Safety Handbook***, Latest Edition

MASTER Technical Module (WLD-A5) dealing with demonstrating knowledge of first aid and CPR.

WLD-A4-HO
Demonstrate Proper Handling of Hazardous Materials
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Use material safety data sheet (MSDS).
B. Identify signs and symbols on hazardous materials used in welding.
C. Discuss safety precautions to be observed with chemical hazards.
D. Discuss safety precautions to be observed welding gas hazards.
E. Demonstrate safe handling of hazardous materials in a work site.

MODULE OUTLINE:

I. Define Hazardous Materials According to the EPA
  A. What makes a material hazardous?
    1. It is hazardous if it causes harm to people or environment
II. Identify Hazardous Materials
  A. Material Safety Data Sheets (MSDS)
    1. Companies that make and distribute hazardous substances must provide your company with a MSDS on hazardous material
    2. MSDS developed by OSHA
    3. MSDS is part of the Hazard Communication Standard or Right to Know regulation
    4. MSDS is an easy reference for information on hazardous substances
  B. Information in MSDS
    1. What it is
    2. Who makes or sells it
    3. Where they are located
    4. Why it is hazardous
    5. How you can be exposed to the hazard
    6. Conditions that could increase the hazard
    7. How to handle the substance safely
    8. Protection to use while working with it
    9. What to do if exposed
    10. What to do if there is a spill or emergency
III. Know the Chemical and Physical Characteristics
  A. Corrosive
    1. Burns skin or eyes on contact
  B. Explosive
  C. Flammable
    1. Catches fire easily
  D. Radioactive
  E. Reactive

        1. Burns, explodes
        2. Releases toxic vapors
    F. Toxic
        1. Causes illness or possibly death

IV. Describe Storage, Transportation, Disposal
    A. Resource Conservation and Recovery Act (RCRA)
        1. Designed to reduce hazards of waste by tracking and regulating the substance
        2. Method used is called from cradle (creation) to grave (disposal)
        3. Tells what hazards are and how to keep track of them
        4. Sets up rules for handling wastes
        5. Provides strict documentation system to track them
    B. Your employer may have to report to the Environmental Protection Agency (EPA) on how the company is meeting the RCRA responsibilities
    C. The law requires companies that treat, store, or dispose of hazardous wastes to:
        1. Have a permit
        2. Identify and analyze new hazardous waste
        3. Provide a secure facility that keeps unauthorized people out
        4. Inspect the facility regularly
        5. Have a contingency plan for fire, explosion, and spills
        6. Practice emergency response for fire, explosion, spills
        7. Provide proper protective clothing and equipment
        8. Maintain EPA-required records

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated
2. Do not talk to anyone who is operating a machine
3. Walk only in the designated traffic lanes
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules

Name: ______________________________ Date: ____________________

WLD-A4
Demonstrate Proper Handling of Hazardous Materials
Self-Assessment

Circle the best answer.

1. The law requires companies that treat, store, or dispose of hazardous wastes to
    a. have a permit
    b. give notice before dumping
    c. have OSHA personnel on site at all times
    d. all of the above

2. Your employer may have to report to the __________ on how the company is meeting the RCRA responsibility.
    a. OSHA
    b. EPA
    c. RCRA
    d. local authorities

3. The EPA requires paperwork that tracks hazardous waste from __________ to __________.
    a. company to company
    b. state to state
    c. cradle to grave
    d. manufacturer to company

4. The key pieces of information in the manifest are __________.
    a. manifest document number
    b. name, address, phone numbers, EPA ID number of generator
    c. description of the hazardous waste
    d. all of the above

5. Who must sign the manifest and keep a copy?
    a. only the manufacturer
    b. only the shipper
    c. only those who dispose of the waste
    d. everyone who handles the waste

6. A material safety data sheet tells you the chemical's __________.
   a. market value
   b. color
   c. physical and chemical characteristics
   d. all of the above

7. If properly wrapped, hazardous waste
   a. may be disposed of at public dumps
   b. must be disposed of according to the EPA guidelines
   c. dumped on private property
   d. all of the above

8. MSDS stands for
   a. material safety data sheet
   b. military secret dumping site
   c. mine safety division storage
   d. material safe disposal site

9. OSHA developed the MSDS as part of __________.
   a. hazard communication standard
   b. right-to-know regulations
   c. Both A and B
   d. Neither A nor B

10. The __________ part of the label can either indicate a specific hazard or what personal protective equipment should be used.
   a. white
   b. red
   c. triangle
   d. cross-hairs

WLD-A4
Demonstrate Proper Handling of Hazardous Materials
Self-Assessment Answer Key

1. a

2. b

3. c

4. d

5. d

6. c

7. b

8. a

9. c

10. a

WLD-A5

WELDER SERIES

MASTER Technical Module No. WLD-A05

SUBJECT: WELDING TECHNICIAN TIME: 3 HOURS

- **DUTY:** **FOLLOW SAFETY PRACTICES**
- **TASK:** Demonstrate A Knowledge Of First Aid And CPR

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Discuss injury hazards which may occur in welding operations;
B. Describe the steps in assisting an injure person;
C. Describe the purpose and location of lock-out switches;
D. Outline the steps for performing CPR;
E. Perform first aid on a simulated injury; and,
F. Perform CPR on laboratory mannequin.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-A5-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-A1	"Demonstrate Understanding of Safety Rules"
WLD-A2	"Assume Personal Safety Standards for Self and Others"
WLD-A3	"Describe the Purpose and Use of Protective Equipment"
WLD-A4	"Demonstrate Proper Handling of Hazardous Material"

INTRODUCTION:

This is Module A5 of the course Welder, Entry Level. It presents techniques to aid and assist persons injured or disabled in welding operations.

PRESENTATION OUTLINE:

In this module students, seeking competency as a welder, will receive:

1. Lecture on common trauma injuries.
2. Lecture on burn injuries.
3. Lecture on breathing problems and cardiac arrest.
4. Performance demonstration on simulated wound(s).
5. Performance demonstration of cardiopulmonary resuscitation (CPR).

PRACTICAL APPLICATION:

This module prepares the student to apply basic measures of first aid and assistance to persons injured on the job. Its application is universal and may benefit the student at any time or place.

EVALUATION AND/OR VERIFICATION:

Upon completion of this module, written examination(s) and competency testing of first aid techniques will be given.

SUMMARY:

This module provides first aid and assistance training for injuries occurring while welding.

NEXT LESSON ASSIGNMENT:

Read: Machine Guarding: Working Safety with Machines in ***Keller's Official OSHA Safety Handbook***, Latest Event

MASTER Technical Module (WLD-A6) dealing with practicing safety precautions when using tools.

WLD-A5-HO
Demonstrate Knowledge of First Aid and CPR
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Discuss injury hazards which may occur in welding operations;
B. Describe the steps in assisting an injure person;
C. Describe the purpose and location of lock-out switches;
D. Outline the steps for performing CPR;
E. Perform first aid on a simulated injury; and,
F. Perform CPR on laboratory mannequin.

MODULE OUTLINE:

In this module students, seeking competency as a welder, will receive:

1. Lecture on common trauma injuries.
2. Lecture on burn injuries.
3. Lecture on breathing problems and cardiac arrest.
4. Performance demonstration on simulated wound(s).
5. Performance demonstration of cardiopulmonary resuscitation (CPR).

WELDER SERIES

MASTER Technical Module No. WLD-A06

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **FOLLOW SAFETY PRACTICES**
- **TASK:** Practice Safety Precautions When Using Tools

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand tool safety;
B. Identify the proper tool to use for specific results;
C. Know the location of others when using tools;
D. List safety precautions for use of manual hand tools;
E. List safety precautions for use of a disc grinder;
F. List safety precautions for use of a bench grinder;
G. List safety precautions for use of a cut off saw;
H. List safety precautions for use of a band saw;
I. List safety precautions for use of a drill press;
J. List safety precautions for use of a hydraulic tool; and,
K. Practice proper maintenance of tools and equipment.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-A6-HO)
MASTER Laboratory Aid (WLD-A6-LA)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall,

(ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-A1	"Demonstrate Understanding of Safety Rules"
WLD-A2	"Assume Personal Safety Standards for Self and Others"
WLD-A3	"Describe the Purpose and Use of Protective Equipment"
WLD-A4	"Demonstrate Proper Handling of Hazardous Material"
WLD-A5	"Demonstrate Knowledge of First Aid and CPR"

INTRODUCTION:

This is Module A6 of the welding program. It instructs students on safety considerations in the use of tools.

PRESENTATION OUTLINE:

I. Identify and Understand Safe Machine Operating Procedures
    A. Never make adjustments on a machine while it is running
        1. Keep guards in place at all times
        2. Discontinue power before servicing
        3. Keep body parts clear of moving machinery
        4. Beware of sharp edges and flying debris
        5. Secure work pieces to prevent slipping
        6. Never stand directly in line with blades or knives
        7. Avoid kickback
        8. Feed stack into machine correctly
    B. Electrical safety
        1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
        2. Stand on dry surface when working on electrical equipment
        3. Replace defective cords or plugs on equipment
        4. Use only those tools that are in good condition
        5. Use only carbon dioxide or dry chemical fire extinguishers for control of electrical fires
        6. Obtain help when working on equipment that may become energized
    C. Avoid horseplay and practical jokes

D. Keep work area clean

II. Demonstrate Safe Machine Operation
- A. Good Housekeeping
  1. Materials and equipment should be stacked straight and neat
  2. Keep aisles and walkways clear of tools, materials, and debris
  3. Dispose of scraps and rubbish daily
  4. Clean up spills
  5. Clean and store hand tools
- B. Good techniques
  1. Always walk – do not run
  2. Never talk to or interrupt anyone who is operating a machine
  3. Never leave tools or pieces of stock lying on table surface of a machine being used
  4. When finished with a machine, turn power OFF and wait until blades or cutters have come to a complete stop before leaving
  5. Check stock for defects before machining
     - a. Do not use a machine until you understand it thoroughly
     - b. Do not jam or rush stock into machinery
     - c. Keep guards in place
     - d. Make sure power is OFF before working on or servicing
  6. Keep hands and fingers away from moving parts
  7. Don't try to run too small a piece through the machine
  8. Use a brush to clean the surface table
  9. Keep your eyes focused on what you are working on
  10. Never use an air hose to blow debris off yourself or other workers
  11. Report faulty machinery to your supervisor
  12. Make sure machinery is properly grounded
  13. Never leave a piece of machinery that is running unattended
  14. Make sure stack is solidly supported
- C. Miscellaneous materials
  1. Molten metal – can splash and cause serious burns
  2. Chemicals – burn or irritate the skin or cause eye damage
  3. Broken glass – causes cuts, can get in the eyes
  4. Pointed objects – knives, screwdrivers, punches, staples can puncture the skin
  5. Rough material – can scrape your skin and cause infections
- D. Machinery
  1. Understand the safety regulations that involve the guarding of moving parts
  2. Know what parts of the equipment are energized
  3. Use all safeguards that have been provided to protect people from machinery
  4. See that all guards and protectors are in place before you start to work
  5. If you must work nearer, turn the machine off and lock out the power
  6. Never work in, around, or near dangerous, unguarded openings

without wearing a safety belt and a lifeline that is properly seamed

E. One-fifth of all injuries on the job involve moving parts, machinery, or tools

---

PRACTICAL APPLICATION:

The student is best prepared when forewarned of the dangers he or she faces when completing a competency based performance of tasks in a hazardous environment. This is the practical application of each module within the duty; Follow Safety Practices.

EVALUATION AND/OR VERIFICATION:

Upon completion of this module, written examination(s) or competency testing will be given to determine student progress.

SUMMARY:

This module reviews the safety considerations for the proper use of hand and power tools.

NEXT LESSON ASSIGNMENT:

Review: Personal Protective Equipment in ***Keller's Official OSHA Safety Handbook***, Latest Edition.

MASTER Technical Module (WLD-A7) dealing with demonstrating proper wearing and use of safety equipment.

WLD-A6-HO
Practice Safety Precautions When Using Tools
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand tool safety;
B. Identify the proper tool to use for specific results;
C. Know the location of others when using tools;
D. List safety precautions for use of manual hand tools;
E. List safety precautions for use of a disc grinder;
F. List safety precautions for use of a bench grinder;
G. List safety precautions for use of a cut off saw;
H. List safety precautions for use of a band saw;
I. List safety precautions for use of a drill press;
J. List safety precautions for use of a hydraulic tool; and,
K. Practice proper maintenance of tools and equipment.

MODULE OUTLINE:

I. Identify and Understand Safe Machine Operating Procedures
  A. Never make adjustments on a machine while it is running
    1. Keep guards in place at all times
    2. Discontinue power before servicing
    3. Keep body parts clear of moving machinery
    4. Beware of sharp edges and flying debris
    5. Secure work pieces to prevent slipping
    6. Never stand directly in line with blades or knives
    7. Avoid kickback
    8. Feed stack into machine correctly
  B. Electrical safety
    1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
    2. Stand on dry surface when working on electrical equipment
    3. Replace defective cords or plugs on equipment
    4. Use only those tools that are in good condition
    5. Use only carbon dioxide or dry chemical fire extinguishers for control of electrical fires
    6. Obtain help when working on equipment that may become energized
  C. Avoid horseplay and practical jokes
  D. Keep work area clean
II. Demonstrate Safe Machine Operation
  A. Good Housekeeping
    1. Materials and equipment should be stacked straight and neat

2. Keep aisles and walkways clear of tools, materials, and debris
3. Dispose of scraps and rubbish daily
4. Clean up spills
5. Clean and store hand tools

B. Good techniques
1. Always walk – do not run
2. Never talk to or interrupt anyone who is operating a machine
3. Never leave tools or pieces of stock lying on table surface of a machine being used
4. When finished with a machine, turn power OFF and wait until blades or cutters have come to a complete stop before leaving
5. Check stock for defects before machining
    a. Do not use a machine until you understand it thoroughly
    b. Do not jam or rush stock into machinery
    c. Keep guards in place
    d. Make sure power is OFF before working on or servicing
6. Keep hands and fingers away from moving parts
7. Don't try to run too small a piece through the machine
8. Use a brush to clean the surface table
9. Keep your eyes focused on what you are working on
10. Never use an air hose to blow debris off yourself or other workers
11. Report faulty machinery to your supervisor
12. Make sure machinery is properly grounded
13. Never leave a piece of machinery that is running unattended
14. Make sure stack is solidly supported

C. Miscellaneous materials
1. Molten metal – can splash and cause serious burns
2. Chemicals – burn or irritate the skin or cause eye damage
3. Broken glass – causes cuts, can get in the eyes
4. Pointed objects – knives, screwdrivers, punches, staples can puncture the skin
5. Rough material – can scrape your skin and cause infections

D. Machinery
1. Understand the safety regulations that involve the guarding of moving parts
2. Know what parts of the equipment are energized
3. Use all safeguards that have been provided to protect people from machinery
4. See that all guards and protectors are in place before you start to work
5. If you must work nearer, turn the machine off and lock out the power
6. Never work in, around, or near dangerous, unguarded openings without wearing a safety belt and a lifeline that is properly seamed

E. One-fifth of all injuries on the job involve moving parts, machinery, or tools

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated
2. Do not talk to anyone who is operating a machine, except in an emergency
3. Walk only in the designated traffic lanes
4. Dress appropriately; at the absolute minimum, you must have:
    a) No loose clothing, including ties;
    b) Long hair properly stowed and secured;
    c) No jewelry;
    d) Hard, closed-toe shoes;
    e) Eye protection (safety glasses); and
    f) Ear protection (plugs or headset).
5. Follow all institutional safety rules

WELDER SERIES

MASTER Technical Module No. WLD-A07

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **FOLLOW SAFETY PRACTICES**
- **TASK:** Demonstrate Proper Wearing And Use Of Safety Equipment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify safety factors;
B. Use face shields, safety glasses, protective apparel, and gloves;
C. Utilize proper breathing apparatus;
D. Demonstrate correct selection of safety equipment for a given task;
E. Demonstrate how the equipment is properly worn; and,
F. Demonstrate proper use of safety equipment for given welding tasks.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-A7-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-A1	"Demonstrate Understanding of Safety Rules"
WLD-A2	"Assume Personal Safety Standards for Self and Others"
WLD-A3	"Describe the Purpose and Use of Protective Equipment"
WLD-A4	"Demonstrate Proper Handling of Hazardous Material"
WLD-A5	"Demonstrate Knowledge of First Aid and CPR"
WLD-A6	"Practice Safety Precautions When Using Tools"

INTRODUCTION:

This is Module A7 of the course Welder Entry Level. It deals with the selection and wearing of welding safety equipment.

PRESENTATION OUTLINE:

In this module students, seeking competency as a welder, will receive:

1. Lecture on welding safety equipment.
2. Demonstration of proper selection of welding safety equipment.
3. Wear personal protective equipment
   a. List personal protective equipment for shielded metal arc welding
   b. List personal protective equipment for gas tungsten arc welding
   c. List personal protective equipment for gas metal arc welding
   d. List personal protective equipment for flux cored arc welding
   e. List personal protective equipment for submerged arc welding
   f. List personal protective equipment for oxy fuel cutting
   g. List personal protective equipment for plasma arc cutting
   h. List personal protective equipment for air carbon arc gouging
   i. During shop work, wear applicable personal protective equipment at all times
   j. List personal safety equipment including clothing, shoes, etc.

PRACTICAL APPLICATION:

The student is best prepared when forewarned of the dangers he or she faces when completing a competency based performance of tasks in a hazardous environment. This is the practical application of each module within the duty; Follow Safety Practices.

EVALUATION AND/OR VERIFICATION:

Upon completion of this module, written examination(s) or competency testing will be given to determine student progress.

SUMMARY:

This module presents the safety equipment available for use of the welder, and demonstrations of how to select and wear it.

NEXT LESSON ASSIGNMENT:

Read: Slips, Trips, and Falls in ***Keller's Official OSHA Safety Handbook***, Latest Edition.

MASTER Technical Module (WLD-A8) dealing with creating and maintaining a safe work station.

WLD-A7-HO
Demonstrate Proper Wearing and Use of Safety Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify safety factors;
B. Use face shields, safety glasses, protective apparel, and gloves;
C. Utilize proper breathing apparatus;
D. Demonstrate correct selection of safety equipment for a given task;
E. Demonstrate how the equipment is properly worn; and,
F. Demonstrate proper use of safety equipment for given welding tasks.

MODULE OUTLINE:

In this module students, seeking competency as a welder, will receive:

1. Lecture on welding safety equipment.
2. Demonstration of proper selection of welding safety equipment.
3. Wear personal protective equipment
   a. List personal protective equipment for shielded metal arc welding
   b. List personal protective equipment for gas tungsten arc welding
   c. List personal protective equipment for gas metal arc welding
   d. List personal protective equipment for flux cored arc welding
   e. List personal protective equipment for submerged arc welding
   f. List personal protective equipment for oxy fuel cutting
   g. List personal protective equipment for plasma arc cutting
   h. List personal protective equipment for air carbon arc gouging
   i. During shop work, wear applicable personal protective equipment at all times
   j. List personal safety equipment including clothing, shoes, etc.

WELDER SERIES
MASTER Technical Module No. WLD-A08

SUBJECT: WELDING TECHNICIAN TIME: 2 HOURS

- **DUTY: FOLLOW SAFETY PRACTICES**
- **TASK:** Create And Maintain A Safe Work Station

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand that a clean work area is a safe work area;
B. Protect self and others from arc flash;
C. Demonstrate eye-safety precautions;
D. Mark "Hot Work";
E. Discuss the safety rules and procedures for using equipment;
F. Identify common hazards in the welding shop, including:
  1. Improper machinery;
  2. Unguarded machinery;
  3. Tripping and falling;
  4. Electrical hazards;
  5. Improper lifting;
  6. Gas and chemical hazards;
G. Explain the importance of "good housekeeping" in the shop; and,
H. Explain the importance of storing material in a secure manner.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-A8-HO1)
MASTER Handout No. 2 (WLD-A8-HO2)
MASTER Laboratory Aid (WLD-A8-LA)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-A1	"Demonstrate Understanding of Safety Rules"
WLD-A2	"Assume Personal Safety Standards for Self and Others"
WLD-A3	"Describe the Purpose and Use of Protective Equipment"
WLD-A4	"Demonstrate Proper Handling of Hazardous Material"
WLD-A5	"Demonstrate Knowledge of First Aid and CPR"
WLD-A6	"Practice Safety Precautions When Using Tools"
WLD-A7	"Demonstrate Proper Wearing and Use of Safety Equipment"

INTRODUCTION:

This is Module A8 of the program for welders. It instructs students in the maintenance of a safe work station.

PRESENTATION OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on workplace safety and the steps for maintaining a safe work station.
2. Identify work station safety rules
    a. List environmental safety precautions, i.e. fume control, radiation reflection, electrical consideration, fire hazards and control, etc.
    b. List equipment safety rules, i.e. ventilation, grounding
    c. Utilize safety when handling and storing compressed gas cylinders
    d. List general shop safety rules
    e. Maintain safe conditions in workstation. Student demonstrate by setting up safe workstation
    f. Comply with confined spaces
3. The set up and demonstration of a safe work station.

PRACTICAL APPLICATION:

The student is best prepared when forewarned of the dangers he or she faces when completing a competency based performance of tasks in a hazardous environment. This is the practical application of each module within the duty; Follow Safety Practices.

EVALUATION AND/OR VERIFICATION:

Upon completion of this module, written examination(s) or competency testing will be given to determine student progress.

SUMMARY:

This module instructs the student on the need for a safe work station and provides demonstrations of safe work stations.

NEXT LESSON ASSIGNMENT:

Review: Welding, Cutting, and Brazing in ***Keller's Official OSHA Safety Handbook***, Latest Edition.

MASTER Technical Module (WLD-A9) dealing with demonstrating safety precautions regarding ARC flash.

WLD-A8-HO1
Create and Maintain a Safe Work Station
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand that a clean work area is a safe work area;
B. Protect self and others from arc flash;
C. Demonstrate eye-safety precautions;
D. Mark "Hot Work";
E. Discuss the safety rules and procedures for using equipment;
F. Identify common hazards in the welding shop, including:
   1. Improper machinery;
   2. Unguarded machinery;
   3. Tripping and falling;
   4. Electrical hazards;
   5. Improper lifting;
   6. Gas and chemical hazards;
G. Explain the importance of "good housekeeping" in the shop; and,
H. Explain the importance of storing material in a secure manner.

MODULE OUTLINE:

I. Keep Work Areas Clean
   A. Discuss the associated dangers of the most common hazards of the work place
      1. Tripping/falling hazards caused by spills, loose objects, etc.
         a. Wipe up spills immediately
         b. Dispose of scrap material
         c. Do not wear loose clothing
         d. Never roll sleeves or pants
         e. Keep shoe strings tied
         f. Position electrical cords and air hoses in safe areas
      2. Chemical hazards
         a. Inhalants
         b. Chemical burns
         c. Flammable liquids
         d. Explosives and explosive combinations
         e. Toxins
      3. Electrical hazards
      4. High-pressure hazards
   B. Discuss methods of avoiding and correcting common hazards
II. Clean Machine/Hand Tools When Work Is Completed
III. Put Tools Away When Work Is Finished
IV. Keep Isles Clear of Equipment and Materials

V. Perform Preventive Maintenance as Required
  A. Discuss that certain machines require extra precautions
  B. Discuss how general maintenance enhances general safety

VI. Understand the Use of Material Safety Data Sheets (MSDS)
  A. What chemicals have MSDS?
  B. Where are the MSDS kept?
  C. What information is on the MSDS?
    1. Product identification
      a. Specific product name and common name
      b. Precautionary labeling
      c. Safety equipment
      d. Precautionary label statements
      e. Storage color code
    2. Hazardous components
    3. Physical data
      a. Boiling point
      b. Vapor pressure
      c. Melting point
      d. Vapor density
      e. Specific gravity
      f. Evaporation rate
      g. Solubility in water
      h. Percentage of volatile components by volume
      i. Appearance & odor
    4. Fire and explosion hazard data
      a. Flash point
      b. NFPA 704M rating
      c. Flammable limits (upper and lower)
      d. Fire extinguishing media
      e. Special fire-fighting procedures
      f. Toxic gases produced
    5. Health hazard data
      a. Threshold limit value
      b. Permissible exposure limit
      c. Toxicity
      d. Carcinogenicity
      e. Effects of over-exposure
      f. Target organs (those most affected by exposure)
      g. Medical conditions aggravated by exposure
      h. Routes of entry
      i. Emergency and first-aid procedures
    6. Reactivity data
      a. Stability
      b. Hazardous polymerization
      c. Conditions to avoid

    - d. Incompatible materials
    - e. Decomposition products
7. Spill and disposal procedures
    - a. Procedures: Spill or discharge
    - b. Procedures: disposal
    - c. EPA hazardous waste number
8. Protective equipment
    - a. Ventilation
    - b. Respiratory protection
    - c. Eye/skin protection
9. Storage and handling precautions
    - a. Storage color code
    - b. Special precautions
10. Transportation data and additional information
    - a. Domestic transport
        - 1) DOT shipping name
        - 2) Hazard class
        - 3) UN/NA
        - 4) Labels
        - 5) Reportable quantity
    - b. International
        - 1) IMO shipping name
        - 2) Hazard class
        - 3) UN/NA
        - 4) Labels

WLD-A8-HO2
Create and Maintain a Safe Work Station
Attachment 2: **MASTER** Handout No. 2

STANDARDS OF PERFORMANCE:

Student shall demonstrate safe work habits in the work shop by:

Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand that a clean work area is a safe work area;
B. Protect self and others from arc flash;
C. Demonstrate eye-safety precautions;
D. Mark "Hot Work";
E. Discuss the safety rules and procedures for using equipment;
F. Identify common hazards in the welding shop, including:
    1. Improper machinery;
    2. Unguarded machinery;
    3. Tripping and falling;
    4. Electrical hazards;
    5. Improper lifting;
    6. Gas and chemical hazards;
G. Explain the importance of "good housekeeping" in the shop; and,
H. Explain the importance of storing material in a secure manner.

READING ASSIGNMENTS:

The following chapters are assigned to read from textbook:

Title
Manual Handling Methods; Lifting and Carrying; Equipment for Handling; Hand Trucks, Ropes, Chains and Slings; Fiber Ropes; Rope Slings

MODULE OUTLINE:

- I. Identify Safety Equipment Used When Working Aloft
  Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA
  - A. Equipment common to most personnel when working aloft
    - 1. Safety glasses
    - 2. Hard hat
    - 3. Safety belt or harness
- II. Describe How to Set up a Portable Ladder for Use
  - A. Portable ladder are broken down in the CFR's as metal and wood ladders
  - B. Wood ladders see 29 CFR 1910.25
    - 1. Single section ladder
    - 2. Two section ladder
    - 3. Special use wood ladders
    - 4. Step ladder
  - C. Metal ladders see 29 CFR 1910.26
  - D. Set up 29 CFR 1910.26
    - 1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall
- III. Basic Safety Concerns While Working from Scaffolding
  Note: This module does not address scaffolding erection because special training is required
  - A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
  - B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
  - C. Never lean over the handrails to perform work
- IV. Concerns While Working from a Man Basket or Personnel Lift
  - A. Use basket or lift for employees and tools only, not freight
  - B. If basket has integral test weights insure weights are removed prior to lifting personnel
  - C. Hands must be inside basket while basket is moving
  - D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
  - E. Always inspect basket rigging prior to entry
  - F. Once the basket is in position it must be tied off if egress from the basket is required
- V. Demonstrate Proper Set up and Use of an Extension Ladder
  - A. Determine wall to base of ladder distance
  - B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

WLD-A8-LA
Create and Maintain a Safe Work Station
Attachment 3: **MASTER** Laboratory Aid

STANDARDS OF PERFORMANCE SAFETY:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing-rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

CONDUCT:

1. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

Name: ______________________________ Date: ________________

WLD-A8
Create and Maintain a Safe Work Station
Self-Assessment

Circle the best answer

1. A chemical label tells:
   A. The carrier where to send the container
   B. Only what the manufacturer wants you to know
   C. Only the maximum hazard
   D. What a chemical's identity is

2. Labels are an important part of
   A. Your company's Hazard Communication Program
   B. Right to know
   C. Both a and b
   D. Neither a nor b

3. On some labels, _____ represent the kind of hazards and _____ represent the degree of hazard.
   A. Colors - numbers
   B. Caution - danger
   C. OSHA - MDS
   D. All of the above

4. Before you start any jobs with chemicals, check the detailed hazard and safety information on the
   A. Supervisor's desk
   B. Material Safety Data Sheet
   C. Dock
   D. Poison control center

5. Chemicals can enter the body by:
   A. Swallowing
   B. Inhaling
   C. Skin contact
   D. All of the above

6. The Control Measures Section of the MSDS covers the:
   A. Protective equipment you might need
   B. Exposure limits
   C. Temperature limits
   D. Spill and leak

7. Which of the following is *not* a good housekeeping rule?
   A. Always put tools in their proper place
   B. Dispose of waste material properly
   C. Sweep debris from machine with hands
   D. Wipe up spills immediately

8. Which of the following is a fire risk?
   A. Disposing of oily rags in tightly covered containers
   B. Storing flammables in electrical closets
   C. Keeping motors and machines free of dust and grease
   D. Keeping passages and fire exits clear

9. Before performing maintenance on a machine you should:
   A. Shut off power
   B. Warn other people
   C. Bring the machine to a zero energy state
   D. Lock-out power and the valves

10. If you have to work on a suspended load you should:
    A. Make sure you have clearance
    B. Place barricades around the hoist
    C. Watch out for pedestrians
    D. Set the load down first

11. Flammable liquids should be stored in:
    A. Open metal containers
    B. Sealed metal containers
    C. Open glass containers
    D. Sealed glass containers

12. During maintenance, the controls of a power-driven conveyor should be locked in the OFF position to prevent:
    A. Start-up
    B. Theft
    C. Damage
    D. Fire

13. When working aloft, you need:
    A. Guard rail clamps
    B. Safety toed shoes
    C. A safety harness
    D. A helper posted below

14. Scrap material should be:
   - A. Stacked around the machine
   - B. Cleared from the area
   - C. Swept out in aisles
   - D. All of the above

15. Danger that is part of the job is a:
   - A. Built-in hazard
   - B. Walk-on hazard
   - C. Accident chain
   - D. Hazardous duty
   - E. Problem for the insurance company, not me

WLD-A8
Create and Maintain a Safe Work Station
Self-Assessment Answer Key

1. D
2. C
3. A
4. B
5. D
6. A
7. C
8. B
9. C
10. D
11. B
12. A
13. C
14. B
15. A

WELDER SERIES
MASTER Technical Module No. WLD-A09

SUBJECT: WELDING TECHNICIAN TIME: 2 HOURS

- **DUTY: FOLLOW SAFETY PRACTICES**
- **TASK:** Demonstrate Safety Precautions Regarding ARC Flash

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Explain danger to eyes from welding operations;
B. Discuss the function of safety equipment in protecting eyes from ARC flash; and,
C. Demonstrate the correct use of eye protection equipment.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-A9-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-A1	"Demonstrate Understanding of Safety Rules"
WLD-A2	"Assume Personal Safety Standards for Self and Others"
WLD-A3	"Describe the Purpose and Use of Protective Equipment"
WLD-A4	"Demonstrate Proper Handling of Hazardous Material"
WLD-A5	"Demonstrate Knowledge of First Aid and CPR"
WLD-A6	"Practice Safety Precautions When Using Tools"
WLD-A7	"Demonstrate Proper Wearing and Use of Safety Equipment"
WLD-A8	"Create and Maintain a Safe Work Station"

INTRODUCTION:

This is Module A9 of the course Welder, Entry Level. It outlines the dangers of, and methods for protection from ARC flash.

PRESENTATION OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on the danger of ARC flash.
2. Demonstration of ARC flash eye protection equipment.

PRACTICAL APPLICATION:

The student is best prepared when forewarned of the dangers he or she faces when completing a competency based performance of tasks in a hazardous environment. This is the practical application of each module within the duty; Follow Safety Practices.

EVALUATION AND/OR VERIFICATION:

Upon completion of this module, written examination(s) or competency testing will be given to determine student progress.

SUMMARY:

This module discusses the dangers of ARC flash and provides demonstration of safety equipment used to protect the eyes.

NEXT LESSON ASSIGNMENT:

Review: Eye Protection, Seeing is Believing in ***Keller's Official***

OSHA Safety Handbook, Latest Edition.

MASTER Technical Module (WLD-A10) dealing with demonstrating eye safety precautions.

WLD-A9
Demonstrate Safety Precautions Regarding ARC Flash
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Explain danger to eyes from welding operations;

B. Discuss the function of safety equipment in protecting eyes from ARC flash; and,

C. Demonstrate the correct use of eye protection equipment.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on the danger of ARC flash.
2. Demonstration of ARC flash eye protection equipment.

WELDER SERIES

MASTER Technical Module No. WLD-A10

SUBJECT: **WELDING TECHNICIAN** **TIME: 2 HOURS**

- **DUTY:** **FOLLOW SAFETY PRACTICES**
- **TASK:** Demonstrate Eye Safety Precautions

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Use safety glasses;
B. Use face shields during operations;
C. Discuss the dangers to eyes found in the welding environment; and,
D. Describe the safety equipment used for eye protection.

REFERENCES:

MASTER Handout (WLD-A10-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-A1	"Demonstrate Understanding of Safety Rules"
WLD-A2	"Assume Personal Safety Standards for Self and Others"
WLD-A3	"Describe the Purpose and Use of Protective Equipment"
WLD-A4	"Demonstrate Proper Handling of Hazardous Material"
WLD-A5	"Demonstrate Knowledge of First Aid and CPR"
WLD-A6	"Practice Safety Precautions When Using Tools"
WLD-A7	"Demonstrate Proper Wearing and Use of Safety Equipment"
WLD-A8	"Create and Maintain a Safe Work Station"
WLD-A9	"Demonstrate Safety Precautions Regarding Arc Flash"

INTRODUCTION:

This is Module A10 of the Welder, Entry Level. It deals with the importance of eye protection in welding operations.

PRESENTATION OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on eye physiology with emphasis on potential for light and/or heat damage.
2. Demonstration of eye hazards found in the welding.environment.

PRACTICAL APPLICATION:

The student is best prepared when forewarned of the dangers he or she faces when completing a competency based performance of tasks in a hazardous environment. This is the practical application of each module within the duty; Follow Safety Practices.

EVALUATION AND/OR VERIFICATION:

Upon completion of this module, written examination(s) or competency testing will be given to determine students progress.

SUMMARY:

This module one of the most critical areas of safety concern for students. It emphasizes the necessity for protecting the eyes at all times during welding operations.

NEXT LESSON ASSIGNMENT:

Review: Personal Protective Equipment in ***Keller's Official OSHA Handbook***, Latest Edition.

MASTER TECHNICAL MODULE (WLD-A11) dealing with performing grinding and brushing technique safety.

WLD-A10-HO
Demonstrate Eye Safety Precautions
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Use safety glasses;
B. Use face shields during operations;
C. Discuss the dangers to eyes found in the welding environment; and,
D. Describe the safety equipment used for eye protection.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on eye physiology with emphasis on potential for light and/or heat damage.
2. Demonstration of eye hazards found in the welding environment.

WELDER SERIES

MASTER Technical Module No. WLD-A11

SUBJECT: **WELDING TECHNICIAN** **TIME: 2 HOURS**

- **DUTY:** **FOLLOW SAFETY PRACTICES**
- **TASK:** Perform Grinding And Brushing Technique Safety

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify the locations of people before operating equipment;
B. Identify the location of flammable or hazardous material before grinding;
C. Demonstrate the safe use of a disc grinder;
D. Demonstrate the safe use of a bench grinder; and,
E. Demonstrate safe technique(s) for brushing.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-A11-HO1)
MASTER Handout No. 2 (WLD-A11-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-A1	"Demonstrate Understanding of Safety Rules"
WLD-A2	"Assume Personal Safety Standards for Self and Others"
WLD-A3	"Describe the Purpose and Use of Protective Equipment"
WLD-A4	"Demonstrate Proper Handling of Hazardous Material"
WLD-A5	"Demonstrate Knowledge of First Aid and CPR"
WLD-A6	"Practice Safety Precautions When Using Tools"
WLD-A7	"Demonstrate Proper Wearing and Use of Safety Equipment"
WLD-A8	"Create and Maintain a Safe Work Station"
WLD-A9	"Demonstrate Safety Precautions Regarding Arc Flash"
WLD-A10	"Demonstrate Eye Safety Precautions"

INTRODUCTION:

This is Module A11 of the course Welder, Entry Level. It outlines safe procedures used when grinding or brushing materials.

PRESENTATION OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on safe grinding, brushing techniques.
2. Lab demonstration on grinding and brushing techniques.

PRACTICAL APPLICATION:

The student is best prepared when forewarned of the dangers he or she faces when completing a competency based performance of tasks in a hazardous environment. This is the practical application of each module within the duty; Follow Safety Practices.

EVALUATION AND/OR VERIFICATION:

Upon completion of this module, written examination(s) or competency testing will be to determine student progress.

SUMMARY:

This module continues the instruction on the need for safe practice in the welding environment. outlining the areas of grinding and brushing.

NEXT LESSON ASSIGNMENT:

Read: Confined Space Entry in ***Keller's Official OSHA Handbook***, Latest Edition.

Review: Welding, Cutting and Brazing in ***Keller's Official OSHA Handbook***, Latest Edition.

MASTER Technical Module (WLD-A12) dealing with maintaining adequate ventilation.

WLD-A11-HO1
Perform Grinding and Brushing Technique Safety
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify the locations of people before operating equipment;
B. Identify the location of flammable or hazardous material before grinding;
C. Demonstrate the safe use of a disc grinder;
D. Demonstrate the safe use of a bench grinder; and,
E. Demonstrate safe technique(s) for brushing.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on safe grinding, brushing techniques.
2. Lab demonstration on grinding and brushing techniques.

WLD-A11-HO2
Perform Grinding and Brushing Technique Safety
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Identify and understand safe machine operating procedures; and,
b. Demonstrate safe machine operation.

MODULE OUTLINE:

I. Identify and Understand Safe Machine Operating Procedures
  A. Never make adjustments on a machine while it is running
    1. Keep guards in place at all times
    2. Discontinue power before servicing
    3. Keep body parts clear of moving machinery
    4. Beware of sharp edges and flying debris
    5. Secure work pieces to prevent slipping
    6. Never stand directly in line with blades or knives
    7. Avoid kickback
    8. Feed stack into machine correctly
  B. Electrical safety
    1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
    2. Stand on dry surface when working on electrical equipment
    3. Replace defective cords or plugs on equipment
    4. Use only those tools that are in good condition
    5. Use only carbon dioxide or dry chemical fire extinguishers for control of electrical fires
    6. Obtain help when working on equipment that may become energized
  C. Avoid horseplay and practical jokes
  D. Keep work area clean.
II. Demonstrate Safe Machine Operation
  A. Good housekeeping
    1. Materials and equipment should be stacked straight and neat
    2. Keep aisles and walkways clear of tools, materials, and debris
    3. Dispose of scraps and rubbish daily
    4. Clean up spills
    5. Clean and store hand tools
  B. Good techniques
    1. Always walk - do not run
    2. Never talk to or interrupt anyone who is operating a machine

3. Never leave tools or pieces of stock lying on table surface of a machine being used
4. When finished with a machine, turn power OFF and wait until blades or cutters have come to a complete stop before leaving
5. Check stock for defects before machining
    a. Do not use a machine until you understand it thoroughly
    b. Do not jam or rush stock into machinery
    c. Keep guards in place
    d. Make sure power is OFF before working on or servicing
6. Keep hands and fingers away from moving parts
7. Don't try to run too small a piece through the machine
8. Use a brush to clean the surface table
9. Keep your eyes focused on what you are working on
10. Never use an air hose to blow debris off yourself or other workers
11. Report faulty machinery to your supervisor
12. Make sure machinery is properly grounded
13. Never leave a piece of machinery that is running unattended
14. Make sure stack is solidly supported

C. Miscellaneous materials
1. Molten metal - can splash and cause serious burns
2. Chemicals - burn or irritate the skin or cause eye damage
3. Broken glass - causes cuts, can get in the eyes
4. Pointed objects - knives, screwdrivers, punches, staples can puncture the skin
5. Rough material - can scrape your skin and cause infections

D. Machinery
1. Understand the safety regulations that involve the guarding of moving parts
2. Know what parts of the equipment are energized
3. Use all safeguards that have been provided to protect people from machinery
4. See that all guards and protectors are in place before you start to work
5. If you must work nearer, turn the machine off and lock out the power
6. Never work in, around, or near dangerous, unguarded openings without wearing a safety belt and a lifeline that is properly seamed

E. One-fifth of all injuries on the job involve moving parts, machinery, or tools

WELDER SERIES

MASTER Technical Module No. WLD-A12

SUBJECT: WELDING TECHNICIAN . **TIME: 2 HOURS**

- **DUTY:** **FOLLOW SAFETY PRACTICES**
- **TASK:** Maintain Adequate Ventilation

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand chemical hazards and MSDS;
B. Use ventilation systems;
C. Use proper breathing apparatus;
D. Recognize a closed work environment;
E. Identify the composition of a normal atmosphere;
F. Discuss the potential dangers to the normal atmosphere during welding operations; and
G. Describe the ventilation requirements for safe welding operations.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-A12-HO1)
MASTER Handout No. 2 (WLD-A12-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition

Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules

WLD-A1	"Demonstrate Understanding of Safety Rules"
WLD-A2	"Assume Personal Safety Standards for Self and Others"
WLD-A3	"Describe the Purpose and Use of Protective Equipment"
WLD-A4	"Demonstrate Proper Handling of Hazardous Material"
WLD-A5	"Demonstrate Knowledge of First Aid and CPR"
WLD-A6	"Practice Safety Precautions When Using Tools"
WLD-A7	"Demonstrate Proper Wearing and Use of Safety Equipment"
WLD-A8	"Create and Maintain a Safe Work Station"
WLD-A9	"Demonstrate Safety Precautions Regarding Arc Flash"
WLD-A10	"Demonstrate Eye Safety Precautions"
WLD-A11	"Perform Grinding and Brushing Technique Safety"

INTRODUCTION:

This is Module A12 of the program for welders. It presents the requirements for ventilation in welding operations.

PRESENTATION OUTLINE:

I. Keep Work Areas Clean
    A. Discuss the associated dangers of the lack of ventilation in the workplace
        1. Chemical Hazards
            a. Inhalants
            b. Chemical burns
            c. Flammable liquids
            d. Explosives and explosive combinations
            e. Toxins
        2. Electrical hazards
        3. High-pressure hazards
    B. Discuss methods of avoiding and correcting common hazards
II. Clean Machine/Hand Tools When Work Is Completed
III. Put Tools Away When Work Is Finished
IV. Keep Isles Clear Of Equipment And Materials
V. Perform Preventive Maintenance As Required
    A. Discuss that certain machines require extra precautions
    B. Discuss how general maintenance enhances general safety

VI. Understand the Use of Material Safety Data Sheets (MSDS)
   A. What chemicals have MSDS?
   B. Where are the MSDS kept?
   C. What information is on the MSDS?
      1. Product identification
         a. Specific product name and common name
         b. Precautionary labeling
         c. Safety equipment
         d. Precautionary label statements
         e. Storage color code
      2. Hazardous components
      3. Physical data
         a. Boiling point
         b. Vapor pressure
         c. Melting point
         d. Vapor density
         e. Specific gravity
         f. Evaporation rate
         g. Solubility in water
         h. Percentage of volatile components by volume
         i. Appearance and odor
      4. Fire and explosion hazard data
         a. Flash point
         b. NFPA 704M rating
         c. Flammable limits (upper and lower)
         d. Fire extinguishing media
         e. Special fire-fighting procedures
         f. Toxic gases produced
      5. Health hazard data
         a. Threshold limit value
         b. Permissible exposure limit
         c. Toxicity
         d. Carcinogenicity
         e. Effects of over-exposure
         f. Target organs (those most affected by exposure)
         g. Medical conditions aggravated by exposure
         h. Routes of entry
         i. Emergency and first-aid procedures
      6. Reactivity data
         a. Stability
         b. Hazardous polymerization
         c. Conditions to avoid
         d. Incompatible materials
         e. Decomposition products
      7. Spill and disposal procedures

    a. Procedures: spill or discharge
    b. Procedures: disposal
    c. EPA hazardous waste number
8. Protective equipment
    a. Ventilation
    b. Respiratory protection
    c. Eye/skin protection
9. Storage and handling precautions
    a. Storage color code
    b. Special precautions
10. Transportation data and additional information
    a. Domestic transport
        1) DOT shipping name
        2) Hazard class
        3) UN/NA
        4) Labels
        5) Reportable quantity
    b. International
        1) IMO shipping name
        2) Hazard class
        3) UN/NA
        4) Labels

PRACTICAL APPLICATION:

The student is best prepared when forewarned of the dangers he or she faces when completing a competency based performance of tasks in a hazardous environment. This is the practical application of each module within the duty; Follow Safety Practices.

EVALUATION AND/OR VERIFICATION:

Upon completion of this module, written examination(s) or competency testing will be given to determine student progress.

SUMMARY:

This module describes the requirements for adequate ventilation in welding operations and/or environments.

NEXT LESSON ASSIGNMENT:

Read: Proper Marking and Identify of "Hot Work" (Lab handout, produced by instructor).

MASTER Technical Module (WLD-A13) dealing with marking hot work.

WLD-A12-HO1
Maintain Adequate Ventilation
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand chemical hazards and MSDS;
B. Use ventilation systems;
C. Use proper breathing apparatus;
D. Recognize a closed work environment;
E. Identify the composition of a normal atmosphere;
F. Discuss the potential dangers to the normal atmosphere during welding operations; and
G. Describe the ventilation requirements for safe welding operations.

MODULE OUTLINE:

I. Keep Work Areas Clean
  A. Discuss the associated dangers of the lack of ventilation in the workplace
    1. Chemical Hazards
      a. Inhalants
      b. Chemical burns
      c. Flammable liquids
      d. Explosives and explosive combinations
      e. Toxins
    2. Electrical hazards
    3. High-pressure hazards
  B. Discuss methods of avoiding and correcting common hazards
II. Clean Machine/Hand Tools When Work Is Completed
III. Put Tools Away When Work Is Finished
IV. Keep Isles Clear Of Equipment And Materials
V. Perform Preventive Maintenance As Required
  A. Discuss that certain machines require extra precautions
  B. Discuss how general maintenance enhances general safety
VI. Understand the Use of Material Safety Data Sheets (MSDS)
  A. What chemicals have MSDS?
  B. Where are the MSDS kept?
  C. What information is on the MSDS?
    1. Product identification
      a. Specific product name and common name
      b. Precautionary labeling

    c. Safety equipment
    d. Precautionary label statements
    e. Storage color code
2. Hazardous components
3. Physical data
    a. Boiling point
    b. Vapor pressure
    c. Melting point
    d. Vapor density
    e. Specific gravity
    f. Evaporation rate
    g. Solubility in water
    h. Percentage of volatile components by volume
    i. Appearance and odor
4. Fire and explosion hazard data
    a. Flash point
    b. NFPA 704M rating
    c. Flammable limits (upper and lower)
    d. Fire extinguishing media
    e. Special fire-fighting procedures
    f. Toxic gases produced
5. Health hazard data
    a. Threshold limit value
    b. Permissible exposure limit
    c. Toxicity
    d. Carcinogenicity
    e. Effects of over-exposure
    f. Target organs (those most affected by exposure)
    g. Medical conditions aggravated by exposure
    h. Routes of entry
    i. Emergency and first-aid procedures
6. Reactivity data
    a. Stability
    b. Hazardous polymerization
    c. Conditions to avoid
    d. Incompatible materials
    e. Decomposition products
7. Spill and disposal procedures
    a. Procedures: spill or discharge
    b. Procedures: disposal
    c. EPA hazardous waste number
8. Protective equipment
    a. Ventilation
    b. Respiratory protection
    c. Eye/skin protection

9. Storage and handling precautions
    a. Storage color code
    b. Special precautions
10. Transportation data and additional information
    a. Domestic transport
        1) DOT shipping name
        2) Hazard class
        3) UN/NA
        4) Labels
        5) Reportable quantity
    b. International
        1) IMO shipping name
        2) Hazard class
        3) UN/NA
        4) Labels

WLD-A12-HO2
Maintain Adequate Ventilation
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Keep work areas clean;
b. Clean machine/hand tools when work is completed;
c. Put tools away when work is finished;
d. Keep isles clear of equipment and materials;
e. Perform preventive maintenance as required; and,
f. Understand chemical hazards and the use of Material Safety Data Sheets (MSDS).

MODULE OUTLINE:

I. Keep Work Areas Clean
    A. Discuss the associated dangers of the lack of ventilation in the workplace
        1. Chemical Hazards
            a. Inhalants
            b. Chemical burns
            c. Flammable liquids
            d. Explosives and explosive combinations
            e. Toxins
        2. Electrical hazards
        3. High-pressure hazards
    B. Discuss methods of avoiding and correcting common hazards
II. Clean Machine/Hand Tools When Work Is Completed
III. Put Tools Away When Work Is Finished
IV. Keep Isles Clear Of Equipment And Materials
V. Perform Preventive Maintenance As Required
    A. Discuss that certain machines require extra precautions
    B. Discuss how general maintenance enhances general safety
VI. Understand the Use of Material Safety Data Sheets (MSDS)
    A. What chemicals have MSDS?
    B. Where are the MSDS kept?
    C. What information is on the MSDS?
        1. Product identification
            a. Specific product name and common name
            b. Precautionary labeling
            c. Safety equipment
            d. Precautionary label statements
            e. Storage color code
        2. Hazardous components
        3. Physical data

   a. Boiling point
   b. Vapor pressure
   c. Melting point
   d. Vapor density
   e. Specific gravity
   f. Evaporation rate
   g. Solubility in water
   h. Percentage of volatile components by volume
   i. Appearance and odor
4. Fire and explosion hazard data
   a. Flash point
   b. NFPA 704M rating
   c. Flammable limits (upper and lower)
   d. Fire extinguishing media
   e. Special fire-fighting procedures
   f. Toxic gases produced
5. Health hazard data
   a. Threshold limit value
   b. Permissible exposure limit
   c. Toxicity
   d. Carcinogenicity
   e. Effects of over-exposure
   f. Target organs (those most affected by exposure)
   g. Medical conditions aggravated by exposure
   h. Routes of entry
   i. Emergency and first-aid procedures
6. Reactivity data
   a. Stability
   b. Hazardous polymerization
   c. Conditions to avoid
   d. Incompatible materials
   e. Decomposition products
7. Spill and disposal procedures
   a. Procedures: spill or discharge
   b. Procedures: disposal
   c. EPA hazardous waste number
8. Protective equipment
   a. Ventilation
   b. Respiratory protection
   c. Eye/skin protection
9. Storage and handling precautions
   a. Storage color code
   b. Special precautions
10. Transportation data and additional information
   a. Domestic transport

   1) DOT shipping name
   2) Hazard class
   3) UN/NA
   4) Labels
   5) Reportable quantity

b. International
   1) IMO shipping name
   2) Hazard class
   3) UN/NA
   4) Labels

WELDER SERIES

MASTER Technical Module No. WLD-A13

SUBJECT: **WELDING TECHNICIAN** **TIME: 2 HOURS**

- **DUTY:** **FOLLOW SAFETY PRACTICES**
- **TASK:** Mark "Hot-Work"

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Define "Hot Work";
B. Identify materials used when marking "Hot Work";
C. Demonstrate techniques for safety marking "Hot Work"; and,
D. Use safety precautions for self and others.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-A13-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey, Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100-E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules

WLD-A1	"Demonstrate Understanding of Safety Rules"
WLD-A2	"Assume Personal Safety Standards for Self and Others"
WLD-A3	"Describe the Purpose and Use of Protective Equipment"
WLD-A4	"Demonstrate Proper Handling of Hazardous Material"
WLD-A5	"Demonstrate Knowledge of First Aid and CPR"
WLD-A6	"Practice Safety Precautions When Using Tools"
WLD-A7	"Demonstrate Proper Wearing and Use of Safety Equipment"
WLD-A8	"Create and Maintain a Safe Work Station"
WLD-A9	"Demonstrate Safety Precautions Regarding Arc Flash"
WLD-A10	"Demonstrate Eye Safety Precautions"
WLD-A11	"Perform Grinding and Brushing Technique Safety"
WLD-A12	"Maintain Adequate Ventilation"

INTRODUCTION:

This is Module A13 of the course Welder, Entry Level. It pertains to the need for properly marking "Hot Work".

PRESENTATION OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on the precautions to be taken when "Hot Work" is present in the shop.
2. Demonstration of proper marking and warning of "Hot Work".

PRACTICAL APPLICATION:

The student is best prepared when forewarned of the dangers he or she faces when completing a competency based performance of tasks in a hazardous environment. This is the practical application of each module within the duty; Follow Safety Practices.

EVALUATION AND/OR VERIFICATION:

Upon completion of this module, written examination(s) or competency testing will be given to determine student progress.

SUMMARY:

This module describes the proper handling of "Hot Work". It is the final module within the duty; Follow Safety Practices. It ends with the reminder that every task in the curriculum for each welder has, as its first enabling objective, follow safety practices!

NEXT LESSON ASSIGNMENT:

Review: Materials studied in modules 1-13 of the duty; A: Follow Safety Practices.

MASTER Technical Module (WLD-B1) dealing with applying principles and tools of continuous quality improvement.

WLD-A13-HO
Mark "Hot Work"
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Define "Hot Work";
B. Identify materials used when marking "Hot Work";
C. Demonstrate techniques for safety marking "Hot Work"; and,
D. Use safety precautions for self and others.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on the precautions to be taken when "Hot Work" is present in the shop.
2. Demonstration of proper marking and warning of "Hot Work".

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	[illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDr.PM6
072996

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES

MASTER Technical Module No. WLD-B01

SUBJECT: **WELDING TECHNICIAN** **TIME: 10 HOURS**

- **DUTY:** **TOTAL QUALITY**
- **TASK:** Apply Principles And Tools Of Continuous Quality Improvement

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Recognize and solve problems; and,
B. Understand what worker empowerment is and how to effectively use.

INSTRUCTIONAL MATERIALS:

Textbook -***Total Quality Management***, Besterfield, Latest Edition
Overhead Projector
Prepared overlays
ISO 9000 Procedures
ANSI Standards
MASTER Handout (WLD-B1-HO)

REFERENCES:

The New Manufacturing Challenge-Techniques for Continuous Improvement, Kiyoshi Suzaki, Latest Edition
Creating Quality- Concepts, Systems, Strategies, and Tools, William J. Kolarik, Latest Edition
Quality System Requirements QS-9000, Chrysler, Ford, General Motors Corporations, Latest Editions
The 90 Day ISO Manual-The Basics, James R. Stewart, Peter Mauch, and Frank Straka, Latest Edition
ISO 9000-An Implementation Guide for Small to Mid-Sized Businesses, Frank Voehl, Peter Jackson, and David Ashton, Latest Edition
Workplace Basics-The Essential Skills Employers Want, Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, Latest Edition
The Motivating Team Leader, Dr. Lewis E. Losoncy, Latest Edition
Organizational Teams-Building Continuous Quality Improvement, Peter Mears, Latest Edition
Team Excellence, Lorber Kamai Associates, Latest Edition

STUDENT PREPARATION:

Introduction To Quality Control Modules

INTRODUCTION:

Course Description: An advanced study of "Total Quality Management" principles concentrating in the areas of Worker Empowerment.

PRESENTATION OUTLINE:

Major Topics: **Worker Empowerment For Continuous Improvement**

I. What is Empowerment?
  A. Define Empowerment
    1. Philosophy that provides each employee an "opportunity" to be creative and make changes to the product and life-cycle processes.
    2. Opportunity includes both the authority to make changes and the authority to do what it takes to enable the change.
    3. Opportunity also means accepting responsibility for your decisions.
  B. Discuss what this means to the class.
    1. Empowerment is more complex than just giving permission to make changes.
    2. Authority or decision-making is a given right and can be easily taken away if proper responsibility is not demonstrated.
    3. Authority is often granted in steps. i.e. You can do up to this before getting further approval from management.
    4. Authority is not to be taken likely. Decision making decisions will be evaluated just as your production etc.
  C. Define Product life cycle processes1. Processes refer to those processes that define, design, develop, produce, deliver, sell, service, use of, disposal/recycling of our products and by-products.
II. Why is empowerment necessary?
  A. To effectively create quality!
  B. The Manufacturers' Alliance for Productivity and Innovation stated that " Organizations that empower employees as a part of their total management effort are twice as likely as other firms to report significant product or service improvement."
  C. Employees will be more motivated to accomplish organizational goals and objectives if they have the authority to make decisions.
III. 4 critical dimensions of empowerment
  A. Teamwork and communication
  B. The evolution of empowerment

- C. The bounds of empowerment
- D. Education and training

IV. Evolution of empowerment
  - A. Empowerment is not a quick fix, attitudes and habits are hard to change and come slowly.
  - B. Empowerment usually requires a change to the company infrastructure.
  - C. Effective empowerment demands personal growth in the areas of trust, technical knowledge.
  - D. Effective empowerment demands a maturing in accepting/using responsibility and authority.
  - E. The growth and maturing will be evolutionary and not accomplished instantly.
  - F. People need time to learn and adjust; some will need to grow more than others.
  - G. Certain individual can not or will not change and may require removal from the team.

V. Discuss Workplace Environment Stages and compare traditional, employee involvement and employee empowerment.

VI. Discuss Six conditions for empowerment - Is a trust-based model.
  - A. Character-Refers to what a person is. i.e. personal virtues such as Vision and enthusiasm, wisdom, courage, commitment, self-discipline, responsibility, persistence, patience, faith, compassion, trustworthiness, and honesty
  - B. Skills-Refers to what a person can do. i.e. personal knowledge of and proficiency in job related activities.
  - C. Win-win agreement-Refers to a social contract which delineates results (desired outcomes), guidelines (policies and procedures), resources (human machine, financial), accountability (performance standards and methods of evaluation), and consequences (organizational and personal impact). Basically an agreement that neither party is harmed at the expense of another. The most difficult and intricate condition.
  - D. Self-supervision-Refers to self-initiation and self-control with respect to the win-win agreement.
  - E. Structures-Refers to the organizational format and functional activities with respect to executing the win-win agreement.
  - F. Accountability-Refers to the establishment and acceptance of personal responsibility for affecting and producing results.

VII. Barriers to success
  - A. Management not supportive, means giving up authority, control by senior management
  - B. Personnel issues
  - C. Supervisor resistance
  - D. Lack of transfer of power to teams
  - E. Misalignment (compensation and team structure)
  - F. Difficulty with new roles (team members, supervisors, or management)

VIII. Bounds on empowerment
  - A. The new boundaries must be identified and communicated to team members to be effective.

1. A new set of expectations must be developed

2. Without careful planning and communication in these areas, misunderstanding and coordination problems will develop

B. Responsibilities are typically assigned to the team, shared, or the supervisors.

1. Team Responsibilities: Survey of responsibilities and percent of teams with.

69% Safety and housekeeping
58% Assign tasks to members
53% Work with internal customers
46% Stop work for quality issues
45% Routing equipment maintenance
44% Vacation scheduling
42% Process improvements
38% Select work methods
34% External customers
33% Determine training needs
29% Set production goals

2. Shared responsibilities:

54% Select work methods
53% Determine training methods
51% Process improvements
49% Set production goals
44% Individual performance problems
44% Routine equipment maintenance
44% External customers

3. Supervisors responsibility:

70% Compensation decisions
55% Prepare and manage budgets
46% Performance appraisals
41% Individual performance problems

C. Key differences between traditional and empowered organizations

1. Empowered firms:
    - Accomplish work through independent teams.
    - Fosters an environment that develops, encourages, and rewards empowered people and teams.
    - Encourage people to build social and technical skills.
    - Align personal and firm goals and see that people understand their roles.
    - Exhibit a high level of individual and team self-management
    - Participate in work design, set direction, and resolve problems.
    - Provide people with the information they need - without asking

ELEMENT	TRADITIONAL ORGANIZATION	SELF-MANAGED TEAMS
Organizational Structure	Layered/Individual	Flat/Team
Job Design	Narrow Single Task	Whole process/multiple tasks
Management Role	Direct Control	Coach/Facilitate
Leadership	Top Down	Shared with Team
Information Flow	Controlled/Limited	Open/Shared
Rewards	Individual/Seniority	Team-based/Skills-based
Job Process	Managers plan, control, and improve processes	Team plan, control, and improve processes

---

PRACTICAL APPLICATION:

The student will be able to:

- Recognize problems and solve them;
- Know what worker empowerment is and why it is important;
- Understand the four critical dimensions of worker empowerment;
- Realize how worker empowerment evolved and the six conditions necessary for worker empowerment;
- Recognize the barriers to success and the bounds on worker empowerment; and,
- Know the differences between traditional and empowered organizations.

EVALUATION AND/OR VERIFICATION:

Class participation, assigned homework, quizzes and exams.

SUMMARY:

There will be a review of each module reemphasizing the important points.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-B2) dealing with understanding the importance of quality in the manufacturing process.

WLD-B1-HO
Apply Principles and Tools of Continuous Quality Improvement
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- A. Recognize and solve problems; and,
- B. Understand what worker empowerment is and how to effectively use.

MODULE OUTLINE:

Major Topics: **Worker Empowerment For Continuous Improvement**

- I. What is Empowerment?
  - A. Define Empowerment
    - 1. Philosophy that provides each employee an "opportunity" to be creative and make changes to the product and life-cycle processes.
    - 2. Opportunity includes both the authority to make changes and the authority to do what it takes to enable the change.
    - 3. Opportunity also means accepting responsibility for your decisions.
  - B. Discuss what this means to the class.
    - 1. Empowerment is more complex than just giving permission to make changes.
    - 2. Authority or decision-making is a given right and can be easily taken away if proper responsibility is not demonstrated.
    - 3. Authority is often granted in steps. i.e. You can do up to this before getting further approval from management.
    - 4. Authority is not to be taken likely. Decision making decisions will be evaluated just as your production etc.
  - C. Define Product life cycle processes1. Processes refer to those processes that define, design, develop, produce, deliver, sell, service, use of, disposal/recycling of our products and by-products.
- II. Why is empowerment necessary?
  - A. To effectively create quality!
  - B. The Manufacturers' Alliance for Productivity and Innovation stated that " Organizations that empower employees as a part of their total management effort are twice as likely as other firms to report significant product or service improvement."
  - C. Employees will be more motivated to accomplish organizational goals and objectives if they have the authority to make decisions.
- III. 4 critical dimensions of empowerment
  - A. Teamwork and communication
  - B. The evolution of empowerment
  - C. The bounds of empowerment

D. Education and training

IV. Evolution of empowerment

A. Empowerment is not a quick fix, attitudes and habits are hard to change and come slowly.

B. Empowerment usually requires a change to the company infrastructure.

C. Effective empowerment demands personal growth in the areas of trust, technical knowledge.

D. Effective empowerment demands a maturing in accepting/using responsibility and authority.

E. The growth and maturing will be evolutionary and not accomplished instantly.

F. People need time to learn and adjust; some will need to grow more than others.

G. Certain individual can not or will not change and may require removal from the team.

V. Discuss Workplace Environment Stages and compare traditional, employee involvement and employee empowerment.

VI. Discuss Six conditions for empowerment - Is a trust-based model.

A. Character-Refers to what a person is. i.e. personal virtues such as Vision and enthusiasm, wisdom, courage, commitment, self-discipline, responsibility, persistence, patience, faith, compassion, trustworthiness, and honesty

B. Skills-Refers to what a person can do. i.e. personal knowledge of and proficiency in job related activities.

C. Win-win agreement-Refers to a social contract which delineates results (desired outcomes), guidelines (policies and procedures), resources (human machine, financial), accountability (performance standards and methods of evaluation), and consequences (organizational and personal impact). Basically an agreement that neither party is harmed at the expense of another. The most difficult and intricate condition.

D. Self-supervision-Refers to self-initiation and self-control with respect to the win-win agreement.

E. Structures-Refers to the organizational format and functional activities with respect to executing the win-win agreement.

F. Accountability-Refers to the establishment and acceptance of personal responsibility for affecting and producing results.

VII. Barriers to success

A. Management not supportive, means giving up authority, control by senior management

B. Personnel issues

C. Supervisor resistance

D. Lack of transfer of power to teams

E. Misalignment (compensation and team structure)

F. Difficulty with new roles (team members, supervisors, or management)

VIII. Bounds on empowerment

A. The new boundaries must be identified and communicated to team members to be effective.

1. A new set of expectations must be developed.

2. Without careful planning and communication in these areas, misunderstanding and coordination problems will develop.

B. Responsibilities are typically assigned to the team, shared, or the supervisors.

1. Team Responsibilities: Survey of responsibilities and percent of teams with.

69% Safety and housekeeping
58% Assign tasks to members
53% Work with internal customers
46% Stop work for quality issues
45% Routing equipment maintenance
44% Vacation scheduling
42% Process improvements
38% Select work methods
34% External customers
33% Determine training needs
29% Set production goals

2. Shared responsibilities:

54% Select work methods
53% Determine training methods
51% Process improvements
49% Set production goals
44% Individual performance problems
44% Routine equipment maintenance
44% External customers

3. Supervisors responsibility:

70% Compensation decisions
55% Prepare and manage budgets
46% Performance appraisals
41% Individual performance problems

C. Key differences between traditional and empowered organizations

1. Empowered firms:

- Accomplish work through independent teams.
- Fosters an environment that develops, encourages, and rewards empowered people and teams.
- Encourage people to build social and technical skills.
- Align personal and firm goals and see that people understand their roles.
- Exhibit a high level of individual and team self-management
- Participate in work design, set direction, and resolve problems.
- Provide people with the information they need - without asking

ELEMENT	TRADITIONAL ORGANIZATION	SELF-MANAGED TEAMS
Organizational Structure	Layered/Individual	Flat/Team
Job Design	Narrow Single Task	Whole process/multiple tasks
Management Role	Direct Control	Coach/Facilitate
Leadership	Top Down	Shared with Team
Information Flow	Controlled/Limited	Open/Shared
Rewards	Individual/Seniority	Team-based/Skills-based
Job Process	Managers plan, control, and improve processes	Team plan, control, and improve processes

WELDER SERIES

MASTER Technical Module No. WLD-B02

SUBJECT: WELDING TECHNICIAN TIME: 10 HOURS

- **DUTY:** **TOTAL QUALITY**
- **TASK:** Understand The Importance Of Quality In The Manufacturing Process

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Define TQM;
B. Understand management philosophy for TQM;
C. Define the concepts of TQM;
D. Understand the cultural changes needed for TQM;
E. Understand TQM organizations; and,
F. Identify quality and the segments to achieve.

INSTRUCTIONAL MATERIALS:

Textbook -***Total Quality Management***, Besterfield, Latest Edition
Overhead Projector
Prepared overlays
ISO 9000 Procedures
ANSI Standards
MASTER Handout (WLD-B2-HO)

REFERENCES:

The New Manufacturing Challenge-Techniques for Continuous Improvement, Kiyoshi Suzaki, Latest Edition
Creating Quality- Concepts, Systems, Strategies, and Tools, William J. Kolarik, Latest Edition
Quality System Requirements QS-9000, Chrysler, Ford, General Motors Corporations, Latest Editions
The 90 Day ISO Manual-The Basics, James R. Stewart, Peter Mauch, and Frank Straka, Latest Edition
ISO 9000-An Implementation Guide for Small to Mid-Sized Businesses, Frank Voehl, Peter Jackson, and David Ashton, Latest Edition
Workplace Basics-The Essential Skills Employers Want, Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, Latest Edition

The Motivating Team Leader, Dr. Lewis E. Losoncy, Latest Edition
Organizational Teams-Building Continuous Quality Improvement, Peter Mears, Latest Edition
Team Excellence, Lorber Kamai Associates, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-B1 "Apply Principles And Tools Of Continuous Quality Improvement"

INTRODUCTION:

Course Description: An advanced study of "Total Quality Management" emphasizing the principles of leadership, customer satisfaction, employee involvement, continuous process improvement, supplier management, and performance measures.

PRESENTATION OUTLINE:

Major Topics: Total Quality Management

- I. Introduction to TQM
    - A. Definition of TQM
        - 1. A leadership philosophy
        - 2. A process, not product orientation
        - 3. A philosophy of continuous improvement
- II. Management Philosophy
    - A. Management responsible for the system, not the worker
- III. Concepts of TQM
- IV. Cultural changes for TQM
- V. TQM Organizations
- VI. Quality
    - A. Defining Quality
    - B. A Customer Right
    - C. Strategy for TQM Implementation
    - D. Planning and Organization for Quality
    - E. Plan-Do-Check-Act

PRACTICAL APPLICATION:

The student will be able to:

- Understand TQM and its definition, responsibility, concepts, and organization; and,
- Determine quality and its definition, strategy for implementation, and organization.

EVALUATION AND/OR VERIFICATION:

Class participation, assigned homework, quizzes and exams.

SUMMARY:

There will be a review of each module reemphasizing the important points.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-B3) dealing with implementing concepts of quality in the workplace.

WLD-B2-HO
Understand the Importance of Quality in the Manufacturing Process
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Define TQM;
B. Understand management philosophy for TQM;
C. Define the concepts of TQM;
D. Understand the cultural changes needed for TQM;
E. Understand TQM organizations; and,
F. Identify quality and the segments to achieve.

MODULE OUTLINE:

Major Topics: Total Quality Management

I. Introduction to TQM
  A. Definition of TQM
    1. A leadership philosophy
    2. A process, not product orientation
    3. A philosophy of continuous improvement
II. Management Philosophy
  A. Management responsible for the system, not the worker
III. Concepts of TQM
IV. Cultural changes for TQM
V. TQM Organizations
VI. Quality
  A. Defining Quality
  B. A Customer Right
  C. Strategy for TQM Implementation
  D. Planning and Organization for Quality
  E. Plan-Do-Check-Act

WELDER SERIES

MASTER Technical Module No. WLD-B03

SUBJECT: **WELDING TECHNICIAN** **TIME: 10 HOURS**

- **DUTY:** **TOTAL QUALITY**
- **TASK:** Implement Concepts Of Quality In The Workplace

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the concepts of continuous process improvement; and,

B. Work through a structured problem solving exercise to improve quality.

INSTRUCTIONAL MATERIALS:

Textbook -***Total Quality Management***, Besterfield, Latest Edition
Overhead Projector
Prepared overlays
ISO 9000 Procedures
ANSI Standards
MASTER Handout (WLD-B3-HO)

REFERENCES:

The New Manufacturing Challenge-Techniques for Continuous Improvement, Kiyoshi Suzaki, Latest Edition
Creating Quality- Concepts, Systems, Strategies, and Tools, William J. Kolarik, Latest Edition
Quality System Requirements QS-9000, Chrysler, Ford, General Motors Corporations, Latest Editions
The 90 Day ISO Manual-The Basics, James R. Stewart, Peter Mauch, and Frank Straka, Latest Edition
ISO 9000-An Implementation Guide for Small to Mid-Sized Businesses, Frank Voehl, Peter Jackson, and David Ashton, Latest Edition
Workplace Basics-The Essential Skills Employers Want, Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, Latest Edition
The Motivating Team Leader, Dr. Lewis E. Losoncy, Latest Edition
Organizational Teams-Building Continuous Quality Improvement, Peter Mears, Latest Edition
Team Excellence, Lorber Kamai Associates, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-B1	"Apply Principles And Tools Of Continuous Quality Improvement"
WLD-B2	"Understand The Importance Of Quality In The Manufacturing Process"

INTRODUCTION:

Course Description: An advanced study of "Total Quality Management" emphasizing the principles of leadership, customer satisfaction, employee involvement, continuous process improvement, supplier management, and performance measures.

PRESENTATION OUTLINE:

Major Topics: **Total Quality Management**

I. Continuous Process Improvement
  A. Principles
    1. Sources
    2. Causes
    3. Statistical Concept of Variation versus Engineering Concept
    4. Improving for stability
II. Structured Problem Solving
  A. Defining the Problem
  B. Implementing Containment Actions
  C. Identifying Root Causes
  D. Developing and Verifying the Solution
  E. Implementing the Solution
  F. Standardize the Improvement

PRACTICAL APPLICATION:

The student will be able to:

- Identify the principles of continuous quality improvement; and,
- Use techniques learned to identify a problem and problem solve.

EVALUATION AND/OR VERIFICATION:

Class participation, assigned homework, quizzes and exams.

SUMMARY:

There will be a review of each module reemphasizing the important points.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-B4) dealing with following the Quality Plan and recommending improvements in work methods or tooling.

WLD-B3-HO
Implement Concepts of Quality in the Workplace
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the concepts of continuous process improvement; and,

B. Work through a structured problem solving exercise to improve quality.

MODULE OUTLINE:

Major Topics: **Total Quality Management**

I. Continuous Process Improvement
  A. Principles
    1. Sources
    2. Causes
    3. Statistical Concept of Variation versus Engineering Concept
    4. Improving for stability
II. Structured Problem Solving
  A. Defining the Problem
  B. Implementing Containment Actions
  C. Identifying Root Causes
  D. Developing and Verifying the Solution
  E. Implementing the Solution
  F. Standardize the Improvement

WELDER SERIES

MASTER Technical Module No. WLD-B04

SUBJECT: WELDING TECHNICIAN TIME: 10 HOURS

- **DUTY:** **TOTAL QUALITY**
- **TASK:** Follow The Quality Plan And Recommend Improvements In Work Methods Or Tooling

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the concepts of quality control;

B. Identify common investigative questions; and,

C. Identify sources of process variations.

INSTRUCTIONAL MATERIALS:

Textbook -***Total Quality Management***, Besterfield, Latest Edition
Overhead Projector
Prepared overlays
ISO 9000 Procedures
ANSI Standards
MASTER Handout (WLD-B4-HO)

REFERENCES:

The New Manufacturing Challenge-Techniques for Continuous Improvement, Kiyoshi Suzaki, Latest Edition
Creating Quality- Concepts, Systems, Strategies, and Tools, William J. Kolarik, Latest Edition
Quality System Requirements QS-9000, Chrysler, Ford, General Motors Corporations, Latest Editions
The 90 Day ISO Manual-The Basics, James R. Stewart, Peter Mauch, and Frank Straka, Latest Edition
ISO 9000-An Implementation Guide for Small to Mid-Sized Businesses, Frank Voehl, Peter Jackson, and David Ashton, Latest Edition
Workplace Basics-The Essential Skills Employers Want, Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, Latest Edition
The Motivating Team Leader, Dr. Lewis E. Losoncy, Latest Edition
Organizational Teams-Building Continuous Quality Improvement, Peter Mears, Latest Edition

Team Excellence, Lorber Kamai Associates, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-B1	"Apply Principles And Tools Of Continuous Quality Improvement"
WLD-B2	"Understand The Importance Of Quality In The Manufacturing Process"
WLD-B3	"Implement Concepts Of Quality In The Workplace"

INTRODUCTION:

Course Description: An advanced study of "Total Quality Management" emphasizing the principles of leadership, customer satisfaction, employee involvement, continuous process improvement, supplier management, and performance measures.

PRESENTATION OUTLINE:

Major Topics: **Total Quality Management**

I. Quality Control
  A. History and Concepts of Quality Control
    1. Corrective Actions
    2. Measurements
    3. Data Used
    4. Implementation
  B. Common Investigative questions
  C. Sources of Process Variations

PRACTICAL APPLICATION:

The student will be able to:

- Use techniques learned to identify a problem and problem solve; and,
- Utilize concepts in Quality Control.

EVALUATION AND/OR VERIFICATION:

Class participation, assigned homework, quizzes and exams.

SUMMARY:

There will be a review of each module reemphasizing the important points.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-B5) dealing with establishing methods, plans and procedures to maintain quality.

WLD-B4-HO

Follow the Quality Plan and Recommend Improvements in Work Methods or Tooling

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the concepts of quality control;
B. Identify common investigative questions; and,
C. Identify sources of process variations.

MODULE OUTLINE:

Major Topics: Total Quality Management

I. Quality Control
  A. History and Concepts of Quality Control
    1. Corrective Actions
    2. Measurements
    3. Data Used
    4. Implementation
  B. Common Investigative questions
  C. Sources of Process Variations

WELDER SERIES

MASTER Technical Module No. WLD-B05

SUBJECT: **WELDING TECHNICIAN** **TIME: 10 HOURS**

- **DUTY:** **TOTAL QUALITY**
- **TASK:** Establish Methods, Plans And Procedures To Maintain Quality

OBJECTIVE(S):

Upon completion of this unit the student will be able to establish methods, plans and procedures to maintain quality.

INSTRUCTIONAL MATERIALS:

Textbook -***Total Quality Management***, Besterfield, Latest Edition
Overhead Projector
Prepared overlays
ISO 9000 Procedures
ANSI Standards
MASTER Handout (WLD-B5-HO)

REFERENCES:

The New Manufacturing Challenge-Techniques for Continuous Improvement, Kiyoshi Suzaki, Latest Edition
Creating Quality- Concepts, Systems, Strategies, and Tools, William J. Kolarik, Latest Edition
Quality System Requirements QS-9000, Chrysler, Ford, General Motors Corporations, Latest Editions
The 90 Day ISO Manual-The Basics, James R. Stewart, Peter Mauch, and Frank Straka, Latest Edition
ISO 9000-An Implementation Guide for Small to Mid-Sized Businesses, Frank Voehl, Peter Jackson, and David Ashton, Latest Edition
Workplace Basics-The Essential Skills Employers Want, Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, Latest Edition
The Motivating Team Leader, Dr. Lewis E. Losoncy, Latest Edition
Organizational Teams-Building Continuous Quality Improvement, Peter Mears, Latest Edition
Team Excellence, Lorber Kamai Associates, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-B1	"Apply Principles And Tools Of Continuous Quality Improvement"
WLD-B2	"Understand The Importance Of Quality In The Manufacturing Process"
WLD-B3	"Implement Concepts Of Quality In The Workplace"
WLD-B4	"Follow The Quality Plan And Recommend Improvements In Work Methods"

INTRODUCTION:

Course Description: An advanced study of "Total Quality Management" emphasizing the principles of leadership, customer satisfaction, employee involvement, continuous process improvement, supplier management, and performance measures.

PRESENTATION OUTLINE:

Major Topics: **Total Quality Management**

I.

PRACTICAL APPLICATION:

The student will be able to establish methods, plans and procedures to maintain quality.

EVALUATION AND/OR VERIFICATION:

Class participation, assigned homework, quizzes and exams.

SUMMARY:

There will be a review of each module reemphasizing the important points.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-C1) dealing with being prompt and on the job in accordance with work schedule.

WLD-B5-HO
Establish Methods, Plans and Procedures to Maintain Quality
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to establish methods, plans and procedures to maintain quality.

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with coworkers and supervisors						
E	Work as a Team	E-1 Understand the roles of coworkers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control postweld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 Perform GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

Duty C

WELDER **... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.**

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on llife of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

384

385-

WELDER SERIES

MASTER Technical Module No. WLD-C01

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **WORK ETHICS**
- **TASK:** Be Prompt and on the Job in Accordance With Work Schedule

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the importance of work schedules;
B. Understand various scheduling methods;
C. Understand the need for promptness and readiness to work on time;
D. Be flexible and willing to help others in case of emergencies; and,
E. Recognize his/her role as a team member.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-C1-HO1)
MASTER Handout No. 2 (WLD-C1-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition
The Ethics of Excellence, Price Prichett, Dallas, TX: Prichett and Associates, Latest Edition
The Power Principle – Influence with Honor, Blaine Lee (Avery Leadership Center), New York: Simon and Shuster, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required courses.

INTRODUCTION:

The course introduction will include:

- The need for good production planning and scheduling of work
- The need for a responsive workforce that is well motivated, willing to work, and capable of work

PRESENTATION OUTLINE:

Instructional Topics:

1. Typical company policies and procedures on attendance and tardiness
2. Policies on disciplinary actions for repeated absences or tardiness
3. Personal planning methods for time scheduling, preparation for work, and travel to work to ensure timely arrival
4. Timely notification of employer in event of emergencies
5. Safety factors, job hazards, and actions to continue operations in event of emergencies
6. Contingency planning for continuation of operations
7. Job transition between shift crews to insure and provide continuation of operations
8. Team advisories for quality, production in planning, materials, and tools
9. Completing the production hand-off transition in an efficient and courteous manner
10. Job priorities and emergency operations plans
11. Personal habits and planning of leisure activities to prevent interferences with work schedule

Student Activities:

Prepare a work schedule that forecasts the cost impact on equipment down time, reduction of production, and project with one hour tardiness of the workforce at 5/ 10 /15% and absenteeism at one work day per month per employee

PRACTICAL APPLICATION:

Organizing personal time and recreational activities, enabling employees to be well rested, prompt, and ready to work at the scheduled time with tools and raw materials

EVALUATION AND/OR VERIFICATION:

Written examination on time scheduling methods and examples of intelligent use of personal time

SUMMARY:

Those employees that arrive late to begin work, and those who fall behind on work schedules are problems of great magnitude in many industries and enterprises. Costs of lost time and lost production can reduce profit by as much as 50 % or more.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-C02) dealing with valuing honest work ethics, dedication, and responsibility in the workplace.

WLD-C1-HO1

Be Prompt and on the Job in Accordance with Work Schedule

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the importance of work schedules;
B. Understand various scheduling methods;
C. Understand the need for promptness and readiness to work on time;
D. Be flexible and willing to help others in case of emergencies; and,
E. Recognize his/her role as a team member.

MODULE OUTLINE:

Instructional Topics:

A. Typical company policies and procedures on attendance and tardiness
B. Policies on disciplinary actions for repeated absences or tardiness
C. Personal planning methods for time scheduling, preparation for work, and travel to work to ensure timely arrival
D. Timely notification of employer in event of emergencies
E. Safety factors, job hazards, and actions to continue operations in event of emergencies
F. Contingency planning for continuation of operations
G. Job transition between shift crews to insure and provide continuation of operations
H. Team advisories for quality, production in planning, materials, and tools
I. Completing the production hand-off transition in an efficient and courteous manner
J. Job priorities and emergency operations plans
K. Personal habits and planning of leisure activities to prevent interferences with work schedule

Student Activities:

Prepare a work schedule that forecasts the cost impact on equipment down time, reduction of production, and project with one hour tardiness of the workforce at 5/ 10 /15% and absenteeism at one work day per month per employee

WLD-C1-H02
Be Prompt and on the Job in Accordance with Work Schedule
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO.

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept. dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or burns?

[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?

[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ______________________________

Audited by: ______________________________ **Date:** ______________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding

- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment

- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings

- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management

- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment

- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions

- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention

- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except aira burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems

- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm hav a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers

- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping

- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections *must* be completed by (date) ______________

Routed to ______________________________ Date ______________

Repairs/corrections from above have been done.

Supervisor ______________________________ Date ______________ Page____ of____

BEST COPY AVAILABLE

WELDER SERIES

MASTER Technical Module No. WLD-C02

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **WORK ETHICS**
- **TASK:** Value Honest Work Ethics, Dedication, and Responsibility in the Workplace

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Assess core values of the individual with those of the work group and corporation; and,

B. Understand the importance of personal ethics to product quality and production outcomes.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-C2-HO1)
MASTER Handout No. 2 (WLD-C2-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition

Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition

Specific Company Safety Policy and Procedures Manual

OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

The Ethics of Excellence, Price Prichett, Dallas, TX: Prichett and Associates, Latest Edition

The Power Principle – Influence with Honor, Blaine Lee (Avery Leadership Center), New York: Simon and Shuster, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following module:

WLD-C1 "Be Prompt and on the Job in Accordance with Work Schedule"

INTRODUCTION:

The course introduction will include:

- Violations of honesty and integrity, however small, dilutes ethical strength and reputation in the job
- High standards and ethics of excellence are necessary for quality production and quality products

PRESENTATION OUTLINE:

Instructional Topics:

1. A code of ethics for professionals
2. The process of values clarification
3. Permit some mistakes so employees can learn
4. Be concerned about small things as well as larger or major events
5. Demonstrate what you believe about ethics in your work
6. Do the right thing, with full consideration of your values
7. Stay out of ethical debt to others
8. Communicate with others
9. Understand the position of each person on the work team

Student Activities:

1. Discuss a case study in situational work ethics
2. Define professional integrity

PRACTICAL APPLICATION:

Don't say what you believe about ethics, demonstrate what you believe by your actions and product outcomes.

EVALUATION AND/OR VERIFICATION:

Students will participate in a core values study and compare their values with those of others in the company

SUMMARY:

Ethics are important elements in the company's culture and reputation. Small indications of the core values can enhance the company's business success, or can devalue it. Each worker's beliefs and actions reflect the aggregate values of the company.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-C03) dealing with demonstrating high moral values.

WLD-C2-HO1
Value Honest Work Ethics, Dedication, and Responsibility in the Workplace
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Assess core values of the individual with those of the work group and corporation; and,

B. Understand the importance of personal ethics to product quality and production outcomes.

MODULE OUTLINE:

Instructional Topics:

1. A code of ethics for professionals
2. The process of values clarification
3. Permit some mistakes so employees can learn
4. Be concerned about small things as well as larger or major events
5. Demonstrate what you believe about ethics in your work
6. Do the right thing, with full consideration of your values
7. Stay out of ethical debt to others
8. Communicate with others
9. Understand the position of each person on the work team

Student Activities:

1. Discuss a case study in situational work ethics
2. Define professional integrity

WLD-C2-H02
Value Honest Work Ethics, Dedication, and Responsibility in the Workplace
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10	Are grinders, saws, and similar equipment provided with appropriate safety guards? [29 CFR 1910.243(a)(1), (c)(1)-(4), (e)(1)(i)]	☐ YES	☐ NO
11	Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer?	☐ YES	☐ NO
12	Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"? [29 CFR 1910.106(d)(3)(ii)]	☐ YES	☐ NO
13	Are flammable liquids, such as gasoline, kept in an approved safety can? [29 CFR 1910.106(d)(2); 144(a)(1)]	☐ YES	☐ NO
14	Are work areas clean? [29 CFR 1910.22(a)]	☐ YES	☐ NO
15	Are work surfaces kept dry or are appropriate means taken to assure the surfaces are slip-resistant? [29 CFR 1910.22(a)(2)]	☐ YES	☐ NO
16	Are all spilled materials or liquids cleaned up immediately? [29 CFR 1910.141(a)(3)(ii)]	☐ YES	☐ NO
17	Are aisles kept clean and free of obstructions? [29 CFR 1910.22(b)(1)]	☐ YES	☐ NO
18	Are fire aisles, access to stairways, and fire equipment kept clear? [29 CFR 1910.178(m)(14)]	☐ YES	☐ NO
19	Are exits kept free of obstructions? [29 CFR 1910.36(d)(1)]	☐ YES	☐ NO
20	Do you control dusts vapors, gases, fumes, smoke, solvents, or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems? [29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)]	☐ YES	☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or burns?

[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?

[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ______________________________

Audited by: ______________________________ **Date:** ______________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding

☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)

☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)

☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)

☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)

☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)

☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment

☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)

☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)

☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings

☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)

☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management

☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)

☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)

☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)

☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)

☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)

☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)

☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)

☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)

☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)

☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)

☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)

☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment

☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)

☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)

☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)

☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)

☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)

☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)

☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)

☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)

☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)

☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)

☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)

☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions

☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)

☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention

☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)

☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?

☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)

☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)

☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)

☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)

☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)

☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)

☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems

☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)

☐ If you have a supervised employee alarm system (that is, does the alarm have a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers

☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)

☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)

☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping

☐ Are aisles marked? 29 CFR 1910.22(b)(2)
☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections must be completed by (date) ______________

Routed to ______________________________ Date ______________

Repairs/corrections from above have been done.

Supervisor ______________________________ Date ______________ Page ____ of ____

BEST COPY AVAILABLE

WELDER SERIES

MASTER Technical Module No. WLD-C03

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **WORK ETHICS**
- **TASK:** Demonstrate High Moral Values

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand that the act of hiring a new employee involves trust by the employer;
B. Understand how to work with honor and respect; and,
C. Follow the principles of honesty on the job.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-C3-HO1)
MASTER Handout No. 2 (WLD-C3-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition
The Ethics of Excellence, Price Prichett, Dallas, TX: Prichett and Associates, Latest Edition
The Power Principle – Influence with Honor, Blaine Lee (Avery Leadership Center), New York: Simon and Shuster, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete the following modules:

WLD-C1	"Be Prompt and on the Job in Accordance with Work Schedule"
WLD-C2	"Value Honest Work Ethics, Dedication, and Responsibility in the Workplace"

INTRODUCTION:

The course introduction will include:

- An overview of the hiring process will be presented
- The importance of honor and respect in the workplace is introduced

PRESENTATION OUTLINE:

Instructional Activities:

1. Continue individual values clarification
2. Meanings and applications of honesty in the workplace
3. Employees in a position of trust and responsibility
4. Working from a perspective of honor and respect

Student Activities:

1. Students will discuss the meaning of "honesty" on the job
2. Students will be asked to take a position on case studies of honesty reflected by the use of property, materials, time, reporting, production rates, and communications

PRACTICAL APPLICATION:

An employee must not only must be skillful in performance of work, but must possess personal values such as honesty and integrity, promptness, and a willingness to work

EVALUATION AND/OR VERIFICATION:

Students will be asked to take a position on case studies of honesty reflected by the use of property, materials, time, reporting, production rates, and communications

SUMMARY:

High moral values are reflected by the employee's stewardship of the assets entrusted by the employer and the "value added" by his efforts and contributions to the work team and the overall enterprise

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-C04) dealing with displaying a neat and clean workplace.

WLD-C3-HO1
Demonstrate High Moral Values
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand that the act of hiring a new employee involves trust by the employer;

B. Understand how to work with honor and respect; and,

C. Follow the principles of honesty on the job.

MODULE OUTLINE:

Instructional Activities:

1. Continue individual values clarification
2. Meanings and applications of honesty in the workplace
3. Employees in a position of trust and responsibility
4. Working from a perspective of honor and respect

Student Activities:

1. Students will discuss the meaning of "honesty" on the job
2. Students will be asked to take a position on case studies of honesty reflected by the use of property, materials, time, reporting, production rates, and communications

WLD-C3-H02
Demonstrate High Moral Values
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept. dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or bums?
[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?
[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ______________________________

Audited by: ______________________________ **Date:** ____________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding

- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment

- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings

- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management

- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment

- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions

- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention

- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems

- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm have a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers

- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping

- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections must be completed by (date) ____________

Routed to ______________________________ Date ____________

Repairs/corrections from above have been done.

Supervisor ______________________________ Date ____________ Page ____ of ____

BEST COPY AVAILABLE

WELDER SERIES

MASTER Technical Module No. WLD-C04

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **WORK ETHICS**
- **TASK:** Display a Neat and Clean Workplace

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the rationale for a clean workplace; and,

B. Apply the principles of planning to the layout of a safe and well-arranged area.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-C4-HO1)
MASTER Handout No. 2 (WLD-C4-HO2)

REFERENCES

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition
The Ethics of Excellence, Price Prichett, Dallas, TX: Prichett and Associates, Latest Edition
The Power Principle – Influence with Honor, Blaine Lee (Avery Leadership Center), New York: Simon and Shuster, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following modules:

WLD-C1	"Be prompt and on the Job in Accordance with Work Schedule"
WLD-C2	"Value Honest Work Ethics, Dedication, and Responsibility in the Workplace"
WLD-C3	"Demonstrate High Moral Values"

INTRODUCTION:

The course introduction will include:

- Overview of the need for safety and proper use/maintenance of tools in the workplace
- Understand that welding is a hazardous occupation that requires exceptional skill in organizing the workplace due to the scope of work and multiple processes and the wide variety of tools that are involved

---

PRESENTATION OUTLINE:

Instructional Topics:

1. Locating and storing tools, fixtures, and raw materials (metals, electrodes, etc.) for efficiency
2. Scheduling of time for cleanup of area and preventive maintenance of tools
3. Scheduling preventive maintenance of machines and apparatus
4. Storage and work accessibility of gases, hoses, and regulators used in welding processes
5. Disposal of generated waste or scrap metal
6. Cleaning methods and tools in support of shop operation

Student Activities:

1. Students will inventory, reorganize, and clean a welding shop in disarray
2. A discussion on "lessons learned" will follow

PRACTICAL APPLICATION:

The use of a disciplined and intelligent approach to workplace layout and maintenance is learned by practice, trial, and errors that must not involve hazardous mistakes. Prescriptive solutions will not always be followed if the student is not convinced of their necessity.

EVALUATION AND/OR VERIFICATION:

Student will assess and evaluate the need for a detailed clean-up of the workplace following a welding exercise; go through equipment shut down and preventive maintenance; and lay out tools, equipment, and raw materials for work plan of the following day

SUMMARY:

Welders need to follow a disciplined and professional approach to layout and maintenance of the workstation. The alternatives to the professional approach are poor planning, lower production rates, less quality, and even greater hazard for accidents and fires

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-C05) dealing with practicing careful use and maintenance of tools and equipment.

WLD-C4-HO1
Display a Neat and Clean Workplace
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the rationale for a clean workplace; and,

B. Apply the principles of planning to the layout of a safe and well-arranged area.

PRESENTATION OUTLINE:

Instructional Topics:

1. Locating and storing tools, fixtures, and raw materials (metals, electrodes, etc.) for efficiency
2. Scheduling of time for cleanup of area and preventive maintenance of tools
3. Scheduling preventive maintenance of machines and apparatus
4. Storage and work accessibility of gases, hoses, and regulators used in welding processes
5. Disposal of generated waste or scrap metal
6. Cleaning methods and tools in support of shop operation

Student Activities:

1. Students will inventory, reorganize, and clean a welding shop in disarray
2. A discussion on "lessons learned" will follow

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept. dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or bums?

[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?

[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ______________________________

Audited by: ______________________________ **Date:** ______________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding

- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment

- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings

- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management

- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment

- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions

- ☐ If welding creates hazardous air emissions—is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention

- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems

- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm have a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers

- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping

- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections must be completed by (date) ______________

Routed to ______________________________ Date ______________

Repairs/corrections from above have been done.

Supervisor ______________________________ Date ______________ Page ____ of ____

BEST COPY AVAILABLE

WELDER SERIES

MASTER Technical Module No. WLD-C05

SUBJECT: WELDING TECHNICIAN TIME: 4 HOURS

- **DUTY: WORK ETHICS**
- **TASK:** Practice Careful Use and Maintenance of Tools and Equipment

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand that careful use means the conduct of safe welding operations with proper tools; and,

B. Understand that preventive maintenance means daily checkout, troubleshooting, and clean-up of equipment and surrounding area.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-C5-HO1)
MASTER Handout No. 2 (WLD-C5-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition
The Ethics of Excellence, Price Prichett, Dallas, TX: Prichett and Associates, Latest Edition
The Power Principle – Influence with Honor, Blaine Lee (Avery Leadership Center), New York: Simon and Shuster, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following modules:

WLD-C1	"Be Prompt and on the Job in Accordance With Work Schedule"
WLD-C2	"Value Honest Work Ethics, Dedication, and Responsibility in the Workplace"
WLD-C3	"Demonstrate High Moral Values"
WLD-C4	"Display a Neat and Clean Workplace"

INTRODUCTION:

An overview of the welder's extensive scope of responsibilities with scheduling, inventory, classification and maintenance of tools, shop equipment, welding equipment, gases, and regulators.

PRESENTATION OUTLINE:

A. Classification of tools by intended purpose or use
B. Specified location of tools and equipment to perform the scope of work
C. Check-out of tools and equipment prior to each shift
D. Reporting of deficiencies, tagging, or replacement of equipment
E. Minor repairs

PRACTICAL APPLICATION:

Student will organize, inspect, and use tools and equipment in a safe and efficient manner

EVALUATION AND/OR VERIFICATION:

Students will inventory, inspect, and lay out the contents of a comprehensive welding shop truck or mobile unit for specified operations

SUMMARY:

The welder is also a multi-skilled specialist in the use and maintenance of shop tools and equipment. He must also apply a structured and disciplined approach to safety, location, maintenance, and availability.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-C6) dealing with being committed to excellence and quality.

WLD-C5-HO1
Practice Careful Use and Maintenance of Tools and Equipment
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand that careful use means the conduct of safe welding operations with proper tools; and,

B. Understand that preventive maintenance means daily checkout, troubleshooting, and clean-up of equipment and surrounding area.

MODULE OUTLINE:

A. Classification of tools by intended purpose or use

B. Specified location of tools and equipment to perform the scope of work

C. Check-out of tools and equipment prior to each shift

D. Reporting of deficiencies, tagging, or replacement of equipment

E. Minor repairs

WLD-C5-H02
Practice Careful Use and Maintenance of Tools and Equipment
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2), (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or burns?
[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?
[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ____________________

Audited by: ____________________ Date: ____________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding

☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment

☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings

☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management

☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment

☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions

☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention

☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems

☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
☐ If you have a supervised employee alarm system (that is, does the alarm hav a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers

☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping

☐ Are aisles marked? 29 CFR 1910.22(b)(2)
☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections *must* be completed by (date) ____________

Routed to ____________________ Date ____________

Repairs/corrections from above have been done.

Supervisor ____________________ Date ____________ Page____ of____

BEST COPY AVAILABLE

WELDER SERIES

MASTER Technical Module No. WLD-C06

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **WORK ETHICS**
- **TASK:** Be Committed to Excellence and Quality

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Practice the selection and use of the right tools for the right job at the right time in the right location;
B. Understand the need for precision and quality in products produced or services delivered; and,
C. Be motivated to achieve only the highest quality through continuous improvement.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-C6-HO1)
MASTER Handout No. 2 (WLD-C6-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition
The Ethics of Excellence, Price Prichett, Dallas, TX: Prichett and Associates, Latest Edition

The Power Principle – Influence with Honor, Blaine Lee (Avery Leadership Center), New York: Simon and Shuster, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following modules:

WLD-C1	"Be Prompt and on the Job in Accordance With Work Schedule"
WLD-C2	"Value Honest Work Ethics, Dedication, and Responsibility in the Workplace"
WLD-C3	"Demonstrate High Moral Values"
WLD-C4	"Display a Neat and Clean Workplace"
WLD-C5	"Practice Careful Use and Maintenance of Tools and Equipment"

INTRODUCTION:

Commitment to excellence is analogous to continued professional effort to achieve a scientific understanding and control of variables in the welding processes. There is also a need for continuous study, practice, and application of skills.

PRESENTATION OUTLINE:

A. Problem solving for welders
B. Benchmarking with the best
C. Continuous improvement methods for welders
D. Control of variables in the welding processes
E. Verifications and inspections for quality weldments

PRACTICAL APPLICATION:

There is proof that welding is a scientific enterprise, but is practiced as a highly-skilled artisan craft based upon techniques and skills that benefit from continuous improvement.

EVALUATION AND/OR VERIFICATION:

Written examination on practical quality methods as used by welding professionals

---

SUMMARY:

Welders achieve quality by scientific job planning and analysis; job layout, fixturing, and measurements; selection of the right methods, processes, and raw materials for the job; selection and preparation of base materials; application of filler metals, shielding gases (as appropriate); fuel gas mixtures or voltage/amperage combinations, appropriate electrodes, alloys; and use of superb, individually applied, techniques of welding.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-C7) dealing with presenting a good company image in attire and attitude.

WLD-C6-HO1
Be Committed to Excellence and Quality
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Practice the selection and use of the right tools for the right job at the right time in the right location;
B. Understand the need for precision and quality in products produced or services delivered; and,
C. Be motivated to achieve only the highest quality through continuous improvement.

MODULE OUTLINE:

A. Problem solving for welders
B. Benchmarking with the best
C. Continuous improvement methods for welders
D. Control of variables in the welding processes
E. Verifications and inspections for quality weldments

WLD-C6-H02
Be Committed to Excellence and Quality
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided
with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard,
or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids,
labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an
approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept. dry or are appropriate means
taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment
kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents.
or mists which may be generated in your workplace through
general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2);
(d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or bums?

[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?

[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ____________________

Audited by: ____________________ **Date:** ____________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding
- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment
- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management
- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment
- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions
- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention
- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems
- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm have a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers
- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping
- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections *must* be completed by (date) ____________

Routed to ____________________ Date ____________

Repairs/corrections from above have been done.

Supervisor ____________________ Date ____________ Page____ of____

BEST COPY AVAILABLE

WELDER SERIES

MASTER Technical Module No. WLD-C07

---

1. **SUBJECT:** **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **WORK ETHICS**
- **TASK:** Present a Good Company Image in Attire and Attitude

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand how impressions and public images are important to product success; and,

B. Understand the significance of company employee attitude, as displayed in public, that may convey lack of respect and concern for customers perceptions.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-C7-HO1)
MASTER Handout No. 2 (WLD-C7-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition
The Ethics of Excellence, Price Prichett, Dallas, TX: Prichett and Associates, Latest Edition
The Power Principle – Influence with Honor, Blaine Lee (Avery Leadership Center), New York: Simon and Shuster, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following modules:

WLD-C1	"Be Prompt and on the Job in Accordance With Work Schedule"
WLD-C2	"Value Honest Work Ethics, Dedication, and Responsibility in the Workplace"
WLD-C3	"Demonstrate High Moral Values"
WLD-C4	"Display a Neat and Clean Workplace"
WLD-C5	"Practice Careful Use and Maintenance of Tools and Equipment"
WLD-C6	"Be Committed to Excellence and Quality"

INTRODUCTION:

An overview on the need for professionals to present themselves in appropriate attire, and appropriate demeanor that demonstrates an attitude of dedication to their profession as well as the production of the highest quality products

PRESENTATION OUTLINE:

1. Welder clothing and protective equipment
2. Actions of a professional versus carefree "party animal" caricature
3. Implications for company reputation and liability if customer has wrong impression of welder
4. Attitudes and demeanor that affect customer opinion of products and services
5. Appearance of equipment or mobile welding truck that influences customer opinion
6. Appropriate use of company logo and markings
7. Inappropriate clothing, bumper stickers, and markings

PRACTICAL APPLICATION:

Assess impact upon company reputation if welders show disregard for personal and public safety; displays bad attitude or demeanor toward customer, product, or company; or, uses unclean, unmaintained equipment.

EVALUATION AND/OR VERIFICATION:

Interview customers concerning their impressions of welder activities on their premises and assess the probability of repeat business from customers interviewed.

SUMMARY:

A good product or service, delivered by employee with carefree attitude, driving in a reckless manner in a company truck, with offensive clothing, caps, or bumper stickers, makes an unforgettable impression on the customer. Some of these impressions may be difficult to overcome.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-C08) dealing with supporting a positive work environment.

WLD-C7-HO1
Present a Good Company Image in Attire and Attitude
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand how impressions and public images are important to product Success; and,

B. Understand the significance of company employee attitude, as displayed in public, that may convey lack of respect and concern for customers perceptions.

MODULE OUTLINE:

1. Welder clothing and protective equipment
2. Actions of a professional versus carefree "party animal" caricature
3. Implications for company reputation and liability if customer has wrong impression of welder
4. Attitudes and demeanor that affect customer opinion of products and services
5. Appearance of equipment or mobile welding truck that influences customer opinion
6. Appropriate use of company logo and markings
7. Inappropriate clothing, bumper stickers, and markings

WLD-C7-H02
Present a Good Company Image in Attire and Attitude
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1	Are empty compressed gas cylinders appropriately marked and their valves closed? [29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)]	☐ YES	☐ NO
2	Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? [29 CFR 1910.253(b)($)(iii)]	☐ YES	☐ NO
3	Does type of PPE used match the needs of current operations? [29 CFR 1910.132(d)(1)(i)]	☐ YES	☐ NO
4	Is each work area adequately ventilated?	☐ YES	☐ NO
5	Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment? [29 CFR 1910.1000(a)]	☐ YES	☐ NO
6	Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working? [29 USC 654, Sec. 5(a)(1)]	☐ YES	☐ NO
7	Are all hazardous chemicals appropriately labeled? [29 CFR 1910.1200(f)(5)&(6)]	☐ YES	☐ NO
8	If hazardous waste is stored, are all hazardous waste requirements complied with?	☐ YES	☐ NO
9	Are rotating or moving parts of equipment guarded to prevent physical contact? [29 CFR 1910.212(a)(1); 243]	☐ YES	☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or burns?
[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?
[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ______________________________

Audited by: ______________________________ **Date:** ______________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding
- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment
- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management
- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment
- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions
- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention
- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems
- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm have a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers
- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping
- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections must be completed by (date) ______________

Routed to ______________________________ Date ______________

Repairs/corrections from above have been done.

Supervisor ______________________________ Date ______________ Page____ of____

BEST COPY AVAILABLE

WELDER SERIES

MASTER Technical Module No. WLD-C08

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **WORK ETHICS**
- **TASK:** Support a Positive Work Environment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate positive attitude and active in support of quality goals; and,

B. Share resources to support fellow workers and work teams.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-C8-HO1)
MASTER Handout No. 2 (WLD-C8-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition
The Ethics of Excellence, Price Prichett, Dallas, TX: Prichett and Associates, Latest Edition
The Power Principle – Influence with Honor, Blaine Lee (Avery Leadership Center), New York: Simon and Shuster, Latest Edition
High Involvement Teamwork, Richard Chang Associates, Inc., Irvine, CA, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following modules:

WLD-C1	"Be Prompt and on the Job in Accordance With Work Schedule"
WLD-C2	"Value Honest Work Ethics, Dedication, and Responsibility in the Workplace"
WLD-C3	"Demonstrate High Moral Values"
WLD-C4	"Display a Neat and Clean Workplace"
WLD-C5	"Practice Careful Use and Maintenance of Tools and Equipment"
WLD-C6	"Be Committed to Excellence and Quality"
WLD-C7	"Present a Good Company Image in Attire and Attitude"

INTRODUCTION:

Overview of methods for increasing employee participation by participative management, worker empowerment, team participation, and motivation for excellent performance of work

PRESENTATION OUTLINE:

1. Definition of a positive work environment
2. Characteristics and indicators of a positive work environment versus a "negative" work environment
3. Worker attitudes and belief systems
4. Helping workers define needs and assisting workers to meet needs
5. Consensus on company goals and worker goals
6. The establishment of "win - win" situations for workers, work teams, and management.

PRACTICAL APPLICATION:

Discuss a case study of the employee owned enterprise, as compared to publicly held corporation of stockholders. Discuss the establishment of positive work environment in each example with similarity of methods and differences in motivational perspectives.

EVALUATION AND/OR VERIFICATION:

Students will compare personal goals with those of a typical enterprise; decide how their needs can be met; accept their responsibilities for participation; and discuss the advantages of a positive work environment.

SUMMARY:

Employees that participate in company planning and goal setting, and those that find that their needs are being met while linked to company success are most supportive of a positive work environment.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-C9) dealing with practicing a positive attitude.

WLD-C8-HO1
Support a Positive Work Environment
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate positive attitude and active in support of quality goals; and,
B. Share resources to support fellow workers and work teams.

MODULE OUTLINE:

1. Definition of a positive work environment
2. Characteristics and indicators of a positive work environment versus a "negative" work environment
3. Worker attitudes and belief systems
4. Helping workers define needs and assisting workers to meet needs
5. Consensus on company goals and worker goals
6. The establishment of "win - win" situations for workers, work teams, and management.

WLD-C8-H02
Support a Positive Work Environment
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept. dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or bums?
[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?
[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ____________________

Audited by: ____________________ **Date:** ____________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding

☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment

☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings

☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management

☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment

☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions

☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention

☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems

☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
☐ If you have a supervised employee alarm system (that is, does the alarm hav a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers

☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping

☐ Are aisles marked? 29 CFR 1910.22(b)(2)
☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections *must* be completed by (date) ____________

Routed to ____________________ Date ____________

Repairs/corrections from above have been done.

Supervisor ____________________ Date ____________ Page____ of____

BEST COPY AVAILABLE

WELDER SERIES

MASTER Technical Module No. WLD-C09

SUBJECT: WELDING TECHNICIAN **TIME:** 4 HOURS

- **DUTY:** WORK ETHICS
- **TASK:** Practice a Positive Attitude

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand basic needs of individuals and groups; and,

B. Understand the benefits of a positive approach to meeting those needs.

INSTRUCTIONAL MATERIALS:

MASTER Handout No. 1 (WLD-C9-HO1)
MASTER Handout No. 2 (WLD-C9-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc. Tinley Park, IL., (ISBN, 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition

Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI. (ISBN 1-897798-21-5), Latest Edition

Specific Company Safety Policy and Procedures Manual

OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, The American Welding Society, Miami, FL, Latest Edition

The Ethics of Excellence, Price Prichett, Dallas, TX: Prichett and Associates, Latest Edition

The Power Principle – Influence with Honor, Blaine Lee (Avery Leadership Center), New York: Simon and Shuster, Latest Edition

High Involvement Teamwork., Richard Chang Associates, Inc., Irvine, CA, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following modules:

WLD-C1	"Be Prompt and on the Job in Accordance With Work Schedule"
WLD-C2	"Value Honest Work Ethics, Dedication, and Responsibility in the Workplace"
WLD-C3	"Demonstrate High Moral Values"
WLD-C4	"Display a Neat and Clean Workplace"
WLD-C5	"Practice Careful Use and Maintenance of Tools and Equipment"
WLD-C6	"Be Committed to Excellence and Quality"
WLD-C7	"Present a Good Company Image in Attire and Attitude"
WLD-C8	"Support a Positive Work Environment"

INTRODUCTION:

Overview of the perception of needs, how needs are reinforced by the "culture" of the individual, those he/she holds in high esteem, and the company. Development of positive goals that can be successful in meeting needs and avoiding of self-destructive behavior that can result in false pursuit of some form of "recognition" or "image."

PRESENTATION OUTLINE:

1. Basic human needs as depicted in Maslow's hierarchy
2. Individual needs, family, and group needs
3. Importance of the relationships of honor and trust with others
4. The importance of recognition for a positive goal of a job well done versus recognition for being "bad" or "cool"
5. The company culture and individual acceptance or denial of this culture
6. Alternatives for the individual in denial of company culture to be discussed
7. Individual attitude toward the work, the workplace, and the co-workers
8. Attitude assessment , process and examples
9. Attitude change process and belief systems from the worker perspective

PRACTICAL APPLICATION:

Discuss case studies of worker attitudes and outcomes that result from positive and negative attitudes

EVALUATION AND/OR VERIFICATION:

Students will participate in an attitude survey process, study their attitudes as a group, and relate this to probabilities of individual and group success

SUMMARY:

Employees need to be equipped with a higher level of interpersonal skills and understanding than in the past, particularly with the advent of work teams and continuous improvement. If they understand themselves better, they will develop positive goals and reach those goals without seeking out destructive or "high risk" behavior patterns.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-D1) dealing with practicing being a good listener.

WLD-C9-HO1
Practice a Positive Attitude
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand basic needs of individuals and groups; and,
B. Understand the benefits of a positive approach to meeting those needs.

PRESENTATION OUTLINE:

1. Basic human needs as depicted in Maslow's hierarchy
2. Individual needs, family, and group needs
3. Importance of the relationships of honor and trust with others
4. The importance of recognition for a positive goal of a job well done versus recognition for being "bad" or "cool"
5. The company culture and individual acceptance or denial of this culture
6. Alternatives for the individual in denial of company culture to be discussed
7. Individual attitude toward the work, the workplace, and the co-workers
8. Attitude assessment , process and examples
9. Attitude change process and belief systems from the worker perspective

---

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept. dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or burns?
[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?
[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ______________________________

Audited by: ______________________________ **Date:** ______________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding

- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment

- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(3), (c)(6)

Equipment Markings

- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management

- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment

- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions

- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention

- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems

- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm hav a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers

- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping

- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections *must* be completed by (date) ______________

Routed to ______________________________ Date ______________

Repairs/corrections from above have been done.

Supervisor ______________________________ Date ______________ Page____ of____

BEST COPY AVAILABLE

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW [illegible] and [illegible] and butt [illegible] on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

[illegible]

Duty D

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES

MASTER Technical Module No. WLD-D01

SUBJECT: **WELDING TECHNICIAN** **TIME: 2 HOURS**

- **DUTY**: **COMMUNICATION SKILLS**
- **TASK**: Practice Being A Good Listener

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Explain the preparations necessary to be an active listener;
B. Describe how to stay involved as a listener;
C. Discuss the importance of listening in the classroom; and,
D. List the barriers to becoming a good listener.

INSTRUCTIONAL MATERIALS:

TEXT:

Communicating Today, Zeuschner, Raymond, Allyn and Bacon, Needham, MA., (ISBN 0-205-14534-5), Latest Edition
MASTER Handout (WLD-D1-HO)

REFERENCES:

Modern Welding, Althouse, Turnquist, Bowditch, & Bowditch, The Goodheart-Wilcox Company, Tinley Park, IL., (ISBN 1-56637-330-1), Latest Edition

STUDENT PREPARATION:

This module was designed to improve communications skills among welders. All students will be able to relate to listening problems "other people" have. Students should come to class with an open mind on this issue and be ready to actively participate in the demonstrations.

INTRODUCTION:

This is Module D1 of the program for welders. It introduces the student to the vital role communication skills play in accomplishing welding tasks. The module examines the first requirement of good communications, being an effective listener.

PRESENTATION OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. A presentation on listening skills, including:
    A. Preparation for listening,
    B. Staying involved as a listener,
    C. Keeping an open mind,
    D. Eliminating barriers to listening.
2. A class discussion group in which every student participates as a speaker and an "active" listener. Each student will be asked to list the main point of every other student speaker.

PRACTICAL APPLICATION:

American technology has brought us to a new phase. We are entering an era of very rapid change often called "the information society". Students seeking vocational skills must master the ability to communicate effectively in order to get and maintain employment in this competitive, constantly evolving work environment. Welders, in particular, need to listen to customers and supervisors as work specifications are being described.

EVALUATION AND/OR VERIFICATION:

At the conclusion of this module, written examination(s) or competency testing will be given to determine student progress.

SUMMARY:

This module introduces the student to the first, and most important step in communication: effective listening.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-D2) dealing with demonstrating good reading, comprehension and writing skills.

WLD-D1-HO

Practice Being a Good Listener

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Explain the preparations necessary to be an active listener;
B. Describe how to stay involved as a listener;
C. Discuss the importance of listening in the classroom; and,
D. List the barriers to becoming a good listener.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. A presentation on listening skills, including:
    A. Preparation for listening,
    B. Staying involved as a listener,
    C. Keeping an open mind,
    D. Eliminating barriers to listening.
2. A class discussion group in which every student participates as a speaker and an "active" listener. Each student will be asked to list the main point of every other student speaker.

WELDER SERIES

MASTER Technical Module No. WLD-D02

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **COMMUNICATION SKILLS**
  TASK: Demonstrate Good Reading, Comprehension and Writing Skills

---

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Read and discuss technical documents on welding;
B. Define important technical welding terms;
C. Explain the need for, and use of, written technical materials; and,
D. Write technical notes, using complete sentences.

INSTRUCTIONAL MATERIALS:

TEXT:

Communicating Today, Zeuschner, Raymond, Allyn and Bacon, Needham, MA., (ISBN 0-205-14534-5), Latest Edition
MASTER Handout (WLD-D2-HO)

REFERENCES:

Modern Welding, Althouse, Turnquist, Bowditch, & Bowditch, The Goodheart-Wilcox Company, Tinley Park, IL., (ISBN 1-56637-330-1), Latest Edition

---

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:
WLD-D1 "Practice Being A Good Listener"

INTRODUCTION:

This is Module D2 of the course for welders. It provides exercises to assist the student in reading and comprehending technical manuals for welding. The exercises require written responses of the student, providing practice in writing effective technical notes in complete sentences.

PRESENTATION OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture(s) containing word exercises on how to read and comprehend technical welding materials.
2. Presentation of technical job functions, responsibilities, and tasks that need to be interpreted and written and transmitted to others.
3. Methods of definition, analysis, and language of the trade that conveys precise meaning.

PRACTICAL APPLICATION:

American technology has brought us to a new phase. We are entering an era of very rapid change often called "the information society". Student will be assigned to write a summary of three of the technical welding exercises that will be presented by the instructor. They will need to interpret the technical terms and write the instructions in language that can be readily understood by others.

EVALUATION AND/OR VERIFICATION:

Each student and the instructor will evaluate the clarity of writing. Students will discuss the instructions if they were to be applied in the welding environment.

SUMMARY:

This module presents methods and exercises in reading and comprehending technical welding materials. Students are instructed in writing effective technical notes in summary exercises. Students seeking vocational skills must master the ability to communicate effectively in order to get and maintain employment in this competitive, constantly evolving work environment.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-D3) dealing with documenting manufacturing processes.

WLD-D2-HO
Demonstrate Good Reading, Comprehension and Writing Skills
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Read and discuss technical documents on welding;
B. Define important technical welding terms;
C. Explain the need for, and use of, written technical materials; and,
D. Write technical notes, using complete sentences.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture(s) containing word exercises on how to read and comprehend technical welding materials.
2. Presentation of technical job functions, responsibilities, and tasks that need to be interpreted and written and transmitted to others.
3. Methods of definition, analysis, and language of the trade that conveys precise meaning.

WELDER SERIES

MASTER Technical Module No. WLD-D03

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **COMMUNICATION SKILLS**
- **TASK:** Document Manufacturing Processes

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Describe a simple welding manufacturing process;
B. Discuss the steps in a welding manufacturing process;
C. Define the terms in a welding manufacturing process; and,
D. When given specifications, document a welding manufacturing process.

INSTRUCTIONAL MATERIALS:

TEXT:

Communicating Today, Zeuschner, Raymond, Allyn and Bacon, Needham, MA., (ISBN 0-205-14534-5), Latest Edition

MASTER Handout (WLD-D3-HO)

REFERENCES:

Modern Welding, Althouse, Turnquist, Bowditch, & Bowditch, The Goodheart-Wilcox Company, Tinley Park, IL., (ISBN 1-56637-330-1), Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-D1 "Practice Being A Good Listener"
WLD-D2 "Demonstrate Good Reading, Comprehension and Writing Skills"

INTRODUCTION:

This is Module D3 of the program for welders. It presents the purpose and techniques for documenting (welding) manufacturing processes.

PRESENTATION OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on the purposes and techniques for documenting welding manufacturing processes.
2. A description of the layout of welding manufacturing work stations
3. A typical sequence of operations
4. Instructions on documenting a typical welding manufacturing process.

PRACTICAL APPLICATION:

Students will document a flow chart and fully describe a typical welding process.

EVALUATION AND/OR VERIFICATION:

Students will critique the work of others for clarity, completeness, technical adequacy, and format. They will also speculate on actions others may take when following the written directions or procedures offered by class members.

SUMMARY:

This module instructs students in documenting (welding) manufacturing processes using written practice exercises.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-D4) dealing with preparing a recommendation for continuous improvement.

WLD-D3-HO
Document Manufacturing Processes
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Describe a simple welding manufacturing process;
B. Discuss the steps in a welding manufacturing process;
C. Define the terms in a welding manufacturing process; and,
D. When given specifications, document a welding manufacturing process.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on the purposes and techniques for documenting welding manufacturing processes.
2. A description of the layout of welding manufacturing work stations
3. A typical sequence of operations
4. Instructions on documenting a typical welding manufacturing process.

WELDER SERIES

MASTER Technical Module No. WLD-D04

SUBJECT: **WELDING TECHNICIAN** **TIME: 5 HOURS**

- **DUTY:** **COMMUNICATION SKILLS**
- **TASK:** Prepare A Recommendation For Continuous Improvement

---

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Describe the steps in a continuous improvement program;
B. Discuss the importance of communication in continuos improvement;
C. Outline the parts of a written recommendation; and,
D. Prepare the data for a continuous improvement recommendation.

INSTRUCTIONAL MATERIALS:

TEXT:

Communicating Today, Zeuschner, Raymond, Allyn and Bacon, Needham, MA., (ISBN 0-205-14534-5), Latest Edition
MASTER Handout (WLD-D4-HO)

REFERENCES:

Modern Welding, Althouse, Turnquist, Bowditch, & Bowditch, The Goodheart-Wilcox Company, Tinley Park, IL., (ISBN 1-56637-330-1), Latest Edition

---

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-D1 "Practice Being A Good Listener"
WLD-D2 "Demonstrate Good Reading, Comprehension and Writing Skills"
WLD-D3 "Document Manufacturing Processes"

INTRODUCTION:

This is Module D4 of the course Welder, Entry Level. It pertains to writing a continuous improvement recommendation for a job or process.

PRESENTATION OUTLINE:

I. Continuous Process Improvement
A. Principles
1. Sources
2. Causes
3. Statistical concept of variation vs. engineering concept
4. Improving for stability

II. Structured Problem Solving
A. Defining the problem
B. Implementing containment actions
C. Identifying root causes
D. Developing and verifying the solution
1. Implementing the solution
2. Standardize the improvement

III. Quality Control
A. History and concepts of Quality Control
1. Corrective actions
2. Measurements
3. Data used
4. Implementation

B. Common investigative questions
C. Sources of process variations

PRACTICAL APPLICATION:

Students will review assigned shops, facilities, and procedures for potential improvements, corrective actions, or recommendations for improvements will be made.

EVALUATION AND/OR VERIFICATION:

Students will read and evaluate the work of others. Finally, the instructor will provide an overall critique.

SUMMARY:

This module provides practical exercises in teaching students how to create written documentation of suggestions for corrective activities and continuous improvement.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-D5) dealing with preparing a summarized priority list of work responsibilities.

WLD-D4-HO
Prepare a Recommendation for Continuous Improvement
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Describe the steps in a continuous improvement program;
B. Discuss the importance of communication in continuos improvement;
C. Outline the parts of a written recommendation; and,
D. Prepare the data for a continuous improvement recommendation.

MODULE OUTLINE:

I. **Continuous Process Improvement**
   A. Principles
      1. Sources
      2. Causes
      3. Statistical concept of variation vs. engineering concept
      4. Improving for stability
II. **Structured Problem Solving**
   A. Defining the problem
   B. Implementing containment actions
   C. Identifying root causes
   D. Developing and verifying the solution
      1. Implementing the solution
      2. Standardize the improvement
III. **Quality Control**
   A. History and concepts of Quality Control
      1. Corrective actions
      2. Measurements
      3. Data used
      4. Implementation
   B. Common investigative questions
   C. Sources of process variations

WELDER SERIES

MASTER Technical Module No. WLD-D05

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY**: **COMMUNICATION SKILLS**
- **TASK**: Prepare A Summarized Priority List Of Work Responsibilities

---

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Explain the need for a priority list of work responsibilities;
B. Discuss how work responsibilities are determined; and,
C. Describe the steps in preparing a priority list of work responsibilities.

INSTRUCTIONAL MATERIALS:

TEXT:

Communicating Today, Zeuschner, Raymond, Allyn and Bacon, Needham, MA., (ISBN 0-205-14534-5), Latest Edition
MASTER Handout (WLD-D5-HO)

REFERENCES:

Modern Welding, Althouse, Turnquist, Bowditch, & Bowditch, The Goodheart-Wilcox Company, Tinley Park, IL., (ISBN 1-56637-330-1), Latest Edition

---

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-D1	"Practice Being A Good Listener"
WLD-D2	"Demonstrate Good Reading, Comprehension and Writing Skills"
WLD-D3	"Document Manufacturing Processes"
WLD-D4	"Prepare A Recommendation For Continuous Improvement"

INTRODUCTION:

This is Module D5 of the program for welders. It outlines the need for developing priority listing of work responsibilities and instructs students on how these lists are created.

PRESENTATION OUTLINE:

1. The need for work priorities
2. How to identify work priorities
3. Criteria for ranking work priorities
4. Creation of summarized work priority lists
5. Priority lists and production methods
6. Work priorities and KANBAN
7. Work schedules and just-in-time methods
8. Sharing resources with the work team

PRACTICAL APPLICATION:

Students will review current shop operations and introduce instructor-provided job orders and create summarized work priority lists. They will then begin the daily planning and assess the time they had previously allotted for work

EVALUATION AND/OR VERIFICATION:

At the conclusion of this module, students will visit a well organized welding shop and benchmark their work priorities and production flow with a well organized state-of-the-art facility.

SUMMARY:

This module instructs students in the need for, and the creation of, priority lists of work responsibilities. It also allows them to benchmark their ideas with current standards and practices.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-D6) dealing with displaying ability to follow directions, give directions and accept constructive criticism.

WLD-D5-HO
Prepare a Summarized Priority List of Work Responsibilities
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Explain the need for a priority list of work responsibilities;
B. Discuss how work responsibilities are determined; and,
C. Describe the steps in preparing a priority list of work responsibilities.

MODULE OUTLINE:

1. The need for work priorities
2. How to identify work priorities
3. Criteria for ranking work priorities
4. Creation of summarized work priority lists
5. Priority lists and production methods
6. Work priorities and KANBAN
7. Work schedules and just-in-time methods
8. Sharing resources with the work team

WELDER SERIES

MASTER Technical Module No. WLD-D06

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY**: **COMMUNICATION SKILLS**
- **TASK**: Display Ability To Follow Directions, Give Directions And Accept Constructive Criticism

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Explain the importance of following direction and instructions of others in the production of quality work;

B. Discuss the ability to convey clear directions when explaining work to others; and,

C. Describe the need to accept, understand, and use constructive criticism in the production of quality work.

INSTRUCTIONAL MATERIALS:

TEXT:

Communicating Today, Zeuschner, Raymond, Allyn and Bacon, Needham, MA., (ISBN 0-205-14534-5), Latest Edition
MASTER Handout (WLD-D6-HO)

REFERENCES:

Modern Welding, Althouse, Turnquist, Bowditch, & Bowditch, The Goodheart-Wilcox Company, Tinley Park, IL., (ISBN 1-56637-330-1), Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-D1	"Practice Being A Good Listener"
WLD-D2	"Demonstrate Good Reading, Comprehension and Writing Skills"
WLD-D3	"Document Manufacturing Processes"
WLD-D4	"Prepare A Recommendation For Continuous Improvement"
WLD-D5	"Prepare A Summarized Priority List Of Work Responsibilities"

INTRODUCTION:

This is Module D6 of the program for welders. It emphasizes the role of receiving and giving direction in the process of welding work production while giving the students an appreciation of the levels of interpersonal skills needed. It instructs on the positive role of constructive criticism in the process of quality work production.

PRESENTATION OUTLINE:

1. Listening to directions
2. Understanding directions clearly, and asking questions when uncertain.
3. The importance of clarity to the production of quality work.
4. The need to convey clear directions to others on the job when needed.
5. The use of welding terms and definitions
    a. Follow verbal instructions
    b. Follow written details
    c. Prepare time and job cards (reports & records)
6. The need to accept and give constructive criticism while maintaining good working relationships with others.
7. The methods of conflict resolution generally accepted in the workplace.

PRACTICAL APPLICATION:

The instructor will explain the need for the use of constructive criticism, and its value in the production of quality work and the process of continuous quality improvement. Students seeking vocational skills must master the ability to communicate effectively in order to get and maintain employment in this competitive, constantly evolving work environment.

EVALUATION AND/OR VERIFICATION:

At the conclusion of this module, written examination(s) or competency testing will be given to determine student progress.

SUMMARY:

This module deals with instructing the student in receiving and giving directions for work in the process of welding. It outlines as well the essential need for constructive criticism and its positive acceptance by the student or employee.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-D7) dealing with demonstrating positive communication skills with co-workers and supervisors.

WLD-D6-HO
Display Ability to Follow Directions, Give Directions And Accept Constructive Criticism
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Explain the importance of following direction and instructions of others in the production of quality work;

B. Discuss the ability to convey clear directions when explaining work to others; and,

C. Describe the need to accept, understand, and use constructive criticism in the production of quality work.

MODULE OUTLINE:

1. Listening to directions
2. Understanding directions clearly, and asking questions when uncertain.
3. The importance of clarity to the production of quality work.
4. The need to convey clear directions to others on the job when needed.
5. The use of welding terms and definitions
   a. Follow verbal instructions
   b. Follow written details
   c. Prepare time and job cards (reports & records)
6. The need to accept and give constructive criticism while maintaining good working relationships with others.
7. The methods of conflict resolution generally accepted in the workplace.

WELDER SERIES

MASTER Technical Module No. WLD-D07

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY**: **COMMUNICATION SKILLS**
- **TASK**: Demonstrate Positive Communication Skills With Co-Workers And Supervisors

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Discuss the importance of communications on the job;
B. Describe the conditions for positive communication to take place;
C. Discuss the role one's attitude plays in positive communication; and,
D. Adapt to changing job or work conditions with a positive approach in communicating with one's supervisors.

INSTRUCTIONAL MATERIALS:

TEXT:

Communicating Today, Zeuschner, Raymond, Allyn and Bacon, Needham, MA., (ISBN 0-205-14534-5), Latest Edition
MASTER Handout (WLD-D7-HO)

REFERENCES:

Modern Welding, Althouse, Turnquist, Bowditch, & Bowditch, The Goodheart-Wilcox Company, Tinley Park, IL., (ISBN 1-56637-330-1), Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-D1	"Practice Being A Good Listener"
WLD-D2	"Demonstrate Good Reading, Comprehension and Writing Skills"
WLD-D3	"Document Manufacturing Processes"
WLD-D4	"Prepare A Recommendation For Continuous Improvement"
WLD-D5	"Prepare A Summarized Priority List Of Work Responsibilities"
WLD-D6	"Display Ability To Follow Directions, Give Directions And Accept Constructive Criticism"

INTRODUCTION:

This is Module D7 of the course Welder, Entry Level. It presents the reasons for developing and using positive communication skills in the workplace for quality work production and worker success and achievement.

PRESENTATION OUTLINE:

1. The use of positive communication skills
2. Workers attitudes and beliefs
3. The need of individual positive reinforcement
4. Goals and positive reinforcement
5. Incentives for quality work

PRACTICAL APPLICATION:

Role playing scenarios will be followed by each student emphasizing the use of good or bad communication skills. Each scenario will be video recorded and critiqued by the class. If communications skills are undesirable, students will then be asked to present a more acceptable solution.

EVALUATION AND/OR VERIFICATION:

At the conclusion of this module, each student will complete an attitude survey or assessment concerning their involvement in the workplace.

SUMMARY:

This module, which concludes instruction on communication skills, repeats the emphasis on the need to develop and use the techniques of positive communication in assuring efficient workers producing quality work.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-E1) dealing with understanding the roles of co-workers.

WLD-D7-HO
Demonstrate Positive Communication Skills with Co-Workers and Supervisors
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Discuss the importance of communications on the job;
B. Describe the conditions for positive communication to take place;
C. Discuss the role one's attitude plays in positive communication; and,
D. Adapt to changing job or work conditions with a positive approach in communicating with one's supervisors.

MODULE OUTLINE:

1. The use of positive communication skills
2. Workers attitudes and beliefs
3. The need of individual positive reinforcement
4. Goals and positive reinforcement
5. Incentives for quality work

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties ← **Tasks** →

	Duties													
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW [illegible] and [illegible] welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
M2 GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3 GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1 Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2 Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-E1
WLD-E2

WELDER SERIES

MASTER Technical Module No. WLD-E01 and WLD-E02

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY**: **WORK AS A TEAM**
- **TASK**: Understand The Roles Of Co-Workers
- **TASK**: Respect Peer Relationships

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Understand and apply the concepts of teams and team building;
B. Apply principles and tools of continuous quality improvement;
C. Understand the importance of quality in manufacturing process;
D. Understand the roles of team members; and,
E. Respect peer relationships.

INSTRUCTIONAL MATERIALS:

TEXT:

The Motivating Team Leader, Dr. Lewis E. Losoncy, Latest Edition

MASTER Handout (WLD-E1 and WLD-E2-HO)

REFERENCES:

The New Manufacturing Challenge – Techniques for Continuous Improvement, Kiyoshi Suzaki, Latest Edition
Creating Quality – Concepts, Systems, Strategies, and Tools, William J. Kolarik, Latest Edition
Quality System Requirements QS9000, Chrysler, Ford, General Motors Corporation, Latest Editions
Workplace Basics – The Essential Skills Employers Want, Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, Latest Edition
Organizational Teams – Building Continuous Quality Improvement, Peter Mears, Latest Edition
Team Excellence, Lorber Kamai Associates, Latest Edition

STUDENT PREPARATION:

Students will prepare by reading text assignments prior to coming to class and will complete prerequisite modules.

INTRODUCTION:

This module prepares the student with teamwork information and an appreciation of the value of his co-workers as they strive to reach shared goals.

PRESENTATION OUTLINE:

I. Definition of Team-A group of people working together to achieve common goals and objectives
- Teamwork is planned because it results from preparation and organization
- The nucleus of team building is trust
- One cornerstone of TQ is a team-based structure
- Synergy – The whole (team) is greater than the sum of its parts (members)

II. Major elements of team synergy
- Listening and clarifying (concentrate on what is being said)
- Supporting (create a positive climate)
- Quality (make a personal commitment to improve)
- Acceptance (respect other member's viewpoints)
- Feedback (honest communication)

III. Achieving positive team synergy
- Getting to know team members

IV. Need for a team
- Most problems occur across functional lines
- 85% of teams are cross-functional
- Change is critical to enable an organization to remain competitive in today's world
- Increasing quality and productivity main reasons for teams

V. Advantages of teamwork
- Improved skills – by accessing more talent, expertise, and technical competence
- Improved communication – communication is both vertical and lateral, is across department lines, more ideas, mutual respect.
- Improved participation – boosts morale, allows for buy-in to changes, higher job satisfaction
- Improved effectiveness – solutions more likely to be implemented, people have process ownership

VI. Team Size
   A. Three basic types of teams

1. Quality Council – Normally high level functional leaders/managers. The council is responsible for establishing and sustaining commitment, direction, and energy for the organization's quality improvement.
2. Work Unit – A group of employees that are responsible for the entire process, including such items as meeting technical specs, schedules, basic production problems, and interface with to some degree, with suppliers and external customers. Supervisors and functional experts take on the role as facilitators and coaches.
3. Cross Functional – A special team put together to address specific situations that require knowledge and expertise from different fields. Team selection normally chosen from those that are affected by the problem, that possess knowledge or expertise related to the problem, and that will be involved with carrying out the solution. Cross functional teams have two distinct advantages; most use a consensus

VII. Roles of Team Members

- Responsibilities
- Accountability

PRACTICAL APPLICATION:

The student will be able to:

- Define what a team is, reasons for a team, and major elements of a team;
- Understand advantages of teamwork, basic types of teams, and types of team conflict;
- Recognize characteristics/conditions of an effective team and main roles for team members; and,
- Recognize problems and solve them.

EVALUATION AND/OR VERIFICATION:

Class participation, assigned homework, quizzes and exams.

SUMMARY:

There will be a review of each module reemphasizing the important points.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-E3) dealing with sharing resources to accomplish necessary tasks.

WLD-E1 and WLD-E2-HO
Understand the Roles of Co-Workers
Respect Peer Relationships
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Understand and apply the concepts of teams and team building;
B. Apply principles and tools of continuous quality improvement;
C. Understand the importance of quality in manufacturing process;
D. Understand the roles of team members; and,
E. Respect peer relationships.

MODULE OUTLINE:

I. Definition of Team-A group of people working together to achieve common goals and objectives
  - Teamwork is planned because it results from preparation and organization
  - The nucleus of team building is trust
  - One cornerstone of TQ is a team-based structure
  - Synergy – The whole (team) is greater than the sum of its parts (members)

II. Major elements of team synergy
  - Listening and clarifying (concentrate on what is being said)
  - Supporting (create a positive climate)
  - Quality (make a personal commitment to improve)
  - Acceptance (respect other member's viewpoints)
  - Feedback (honest communication)

III. Achieving positive team synergy
  - Getting to know team members

IV. Need for a team
  - Most problems occur across functional lines
  - 85% of teams are cross-functional
  - Change is critical to enable an organization to remain competitive in today's world
  - Increasing quality and productivity main reasons for teams

V. Advantages of teamwork
  - Improved skills – by accessing more talent, expertise, and technical competence
  - Improved communication – communication is both vertical and lateral, is across department lines, more ideas, mutual respect.
  - Improved participation – boosts morale, allows for buy-in to changes, higher job satisfaction

- Improved effectiveness – solutions more likely to be implemented, people have process ownership

VI. Team Size

  A. Three basic types of teams

    1. Quality Council – Normally high level functional leaders/managers. The council is responsible for establishing and sustaining commitment, direction, and energy for the organization's quality improvement.
    2. Work Unit – A group of employees that are responsible for the entire process, including such items as meeting technical specs, schedules, basic production problems, and interface with to some degree, with suppliers and external customers. Supervisors and functional experts take on the role as facilitators and coaches.
    3. Cross Functional – A special team put together to address specific situations that require knowledge and expertise from different fields. Team selection normally chosen from those that are affected by the problem, that possess knowledge or expertise related to the problem, and that will be involved with carrying out the solution. Cross functional teams have two distinct advantages; most use a consensus

VII. Roles of Team Members

- Responsibilities
- Accountability

WELDER SERIES

MASTER Technical Module No. WLD-E03

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY**: **WORK AS A TEAM**
- **TASK**: Share Resources to Accomplish Necessary Tasks

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Define resources that are individually held and commonly held in production operations;
B. Demonstrate how resources can be more economically applied, with greater force, and with more lasting effect if they are shared by workers; and,
C. Explain the responsibility and outcomes of sharing resources.

INSTRUCTIONAL MATERIALS:

TEXT:

The Motivating Team Leader, Dr. Lewis E. Losoncy, Latest Edition

MASTER Handout (WLD-E3-HO)

REFERENCES:

The New Manufacturing Challenge – Techniques for Continuous Improvement, Kiyoshi Suzaki, Latest Edition
Creating Quality – Concepts, Systems, Strategies, and Tools, William J. Kolarik, Latest Edition
Quality System Requirements QS9000, Chrysler, Ford, General Motors Corporation, Latest Editions
Workplace Basics – The Essential Skills Employers Want, Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, Latest Edition
Organizational Teams – Building Continuous Quality Improvement, Peter Mears, Latest Edition
Team Excellence, Lorber Kamai Associates, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-E1 “Understand The Roles Of Co-Workers”
WLD-E2 “Respect Peer Relationships”

INTRODUCTION:

This module will demonstrate to each student the importance of sharing resources.

PRESENTATION OUTLINE:

I. Characteristics of an Effective Team
  - The atmosphere is informal and relaxed, without obvious tension
  - Everyone participates in the discussion
  - The team’s task is understood and accepted by the members
  - Members listen to each other; each idea is given a hearing.
  - The team is comfortable with disagreement and does not avoid conflict simply to keep everything in agreement.
  - Decisions are reached by consensus.
  - Criticism is frequent, frank, and relatively comfortable with no personal attacks.
  - People are free to express their feelings and ideas on the team’s problems.
  - When action is taken, clear assignments are made and accepted.
  - The leader does not dominate, nor does the team.
  - The team is self-conscious about how it functions and examines how it is performing.
  - Team members can recognize and can work with a variety of personalities
  - Each team member is aware of the skills of the other members and how these skills can be applied to reach the team’s goals.

II. Reasons Why Teamwork and Sharing is Crucial for Effectiveness/Excellence
  - Is a crucial element of the empowerment process.
  - Allows for the pooling or complement of each others skills.
  - Not all change results in improvement.
  - A change (improvement) in one area may result in an impact for another area.

III. Conditions for an Effective Team
  - Interdependence – Working on problems that each person has a stake. Teamwork is crucial.
  - Effective leadership – The leader will take risks to improve group performance.
  - Joint Decision – All members agree to participate.
  - Equal influence – Each member has an equal vote, equal say. Teams must become proficient in both problem-solving and decision making processes.

IV. Three Main Roles for Team Members
  - Group task. Initiator-contributor, information seeker, opinion seeker, opinion giver, elaborator, coordinator, orienter, evaluator critic, energizer, procedural technician, recorder

- Group maintenance. Encourager, harmonizer, compromiser, gate keeper and expediter, standard setter, group observer, follower.
- Individual. Team player, aggressor, blocker, recognition seeker, self-professor, playboy, dominator, help seeker, special interest pleader.

V. Importance of sharing resources to improve mission accomplishment

---

PRACTICAL APPLICATION:

Students will participate in exercises that can not be accomplished unless resources are shared.

EVALUATION AND/OR VERIFICATION:

Class participation, assigned homework, quizzes and exams.

SUMMARY:

The sharing of resources and the need to work well together go hand in hand for successful mission accomplishment.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-E4) dealing with facilitating the work ethic by completing tasks in time and accurately.

WLD-E3-HO
Share Resources to Accomplish Necessary Tasks
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Define resources that are individually held and commonly held in production operations;
B. Demonstrate how resources can be more economically applied, with greater force, and with more lasting effect if they are shared by workers; and,
C. Explain the responsibility and outcomes of sharing resources.

MODULE OUTLINE:

I. Characteristics of an Effective Team
  - The atmosphere is informal and relaxed, without obvious tension
  - Everyone participates in the discussion
  - The team's task is understood and accepted by the members
  - Members listen to each other; each idea is given a hearing.
  - The team is comfortable with disagreement and does not avoid conflict simply to keep everything in agreement.
  - Decisions are reached by consensus.
  - Criticism is frequent, frank, and relatively comfortable with no personal attacks.
  - People are free to express their feelings and ideas on the team's problems.
  - When action is taken, clear assignments are made and accepted.
  - The leader does not dominate, nor does the team.
  - The team is self-conscious about how it functions and examines how it is performing.
  - Team members can recognize and can work with a variety of personalities
  - Each team member is aware of the skills of the other members and how these skills can be applied to reach the team's goals.

II. Reasons Why Teamwork and Sharing is Crucial for Effectiveness/Excellence
  - Is a crucial element of the empowerment process.
  - Allows for the pooling or complement of each others skills.
  - Not all change results in improvement.
  - A change (improvement) in one area may result in an impact for another area.

III. Conditions for an Effective Team
  - Interdependence – Working on problems that each person has a stake. Teamwork is crucial.
  - Effective leadership – The leader will take risks to improve group performance.
  - Joint Decision – All members agree to participate.

- Equal influence – Each member has an equal vote, equal say. Teams must become proficient in both problem-solving and decision making processes.

IV. Three Main Roles for Team Members

- Group task. Initiator-contributor, information seeker, opinion seeker, opinion giver, elaborator, coordinator, orienter, evaluator critic, energizer, procedural technician, recorder
- Group maintenance. Encourager, harmonizer, compromiser, gate keeper and expediter, standard setter, group observer, follower.
- Individual. Team player, aggressor, blocker, recognition seeker, self-professor, playboy, dominator, help seeker, special interest pleader.

V. Importance of sharing resources to improve mission accomplishment

WELDER SERIES

MASTER Technical Module No. WLD-E04

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY**: **WORK AS A TEAM**
- **TASK**: Facilitate the Work Ethic by Completing Tasks On Time and Accurately

---

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Encourage good work ethics;
B. Maintain time and work attendance;
C. Encourage honesty, quality work and high standards; and,
D. Provide a fair rate of work at high quality for the invested time.

INSTRUCTIONAL MATERIALS:

TEXT:

The Motivating Team Leader, Dr. Lewis E. Losoncy, Latest Edition

MASTER Handout (WLD-E4-HO)

REFERENCES:

The New Manufacturing Challenge – Techniques for Continuous Improvement, Kiyoshi Suzaki, Latest Edition
Creating Quality – Concepts, Systems, Strategies, and Tools, William J. Kolarik, Latest Edition
Quality System Requirements QS9000, Chrysler, Ford, General Motors Corporation, Latest Editions
Workplace Basics – The Essential Skills Employers Want, Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, Latest Edition
Organizational Teams – Building Continuous Quality Improvement, Peter Mears, Latest Edition
Team Excellence, Lorber Kamai Associates, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-E1	"Understand The Roles Of Co-Workers"
WLD-E2	"Respect Peer Relationships"
WLD-E3	"Share Resources to Accomplish Necessary Tasks"

INTRODUCTION:

This module will demonstrate to each student that good work ethics are the hallmark of the professional.

PRESENTATION OUTLINE:

1. Why be concerned about work ethics?
   A technician or craftsman's reputation has great value (to be enhanced or diminished). Responsibility to employer for quality work performed in a timely manner without defect.
2. What is a fair rate of work?
   Supply, demand, and ethics. Team roles and responsibilities.

PRACTICAL APPLICATION:

Students will be placed in situational circumstances where work ethics are demonstrated and discussed. Students will be placed in teams and given work to perform.

EVALUATION AND/OR VERIFICATION:

Students will make a list of the work ethics they will follow and this will be referred to instructor for evaluation or further discussion. Students will evaluate the effectiveness of work before and after team assignments.

SUMMARY:

Work ethics are required before work teams can become effective.

NEXT LESSON ASSIGNMENT:

MASTER Technical Modules (WLD-E5 and WLD-E6) dealing with being involved with problem solving and applying creative thinking.

WLD-E4-HO
Facilitate the Work Ethic by Completing Tasks On Time and Accurately
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Encourage good work ethics;
B. Maintain time and work attendance;
C. Encourage honesty, quality work and high standards; and,
D. Provide a fair rate of work at high quality for the invested time.

MODULE OUTLINE:

1. Why be concerned about work ethics?
   A technician or craftsman's reputation has great value (to be enhanced or diminished). Responsibility to employer for quality work performed in a timely manner without defect.
2. What is a fair rate of work?
   Supply, demand, and ethics. Team roles and responsibilities.

WLD-E5
WLD-E6

WELDER SERIES

MASTER Technical Module No. WLD-E05 and WLD-E06

SUBJECT: **WELDING TECHNICIAN** **TIME: 6 HOURS**

- **DUTY**: **WORK AS A TEAM**
- **TASK**: Be Involved With Problem Solving
- **TASK**: Apply Creative Thinking

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Enable students to experience and solve problems with various methods and tools;
B. Encourage proper definition of the problem; and,
C. Understand root cause failure analysis.

INSTRUCTIONAL MATERIALS:

TEXT:

The Motivating Team Leader, Dr. Lewis E. Losoncy, Latest Edition

MASTER Handout (WLD-E5 and WLD-E6-HO)

REFERENCES:

The New Manufacturing Challenge – Techniques for Continuous Improvement, Kiyoshi Suzaki, Latest Edition
Creating Quality – Concepts, Systems, Strategies, and Tools, William J. Kolarik, Latest Edition
Quality System Requirements QS9000, Chrysler, Ford, General Motors Corporation, Latest Editions
Workplace Basics – The Essential Skills Employers Want, Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, Latest Edition
Organizational Teams – Building Continuous Quality Improvement, Peter Mears, Latest Edition
Team Excellence, Lorber Kamai Associates, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-E1	"Understand The Roles Of Co-Workers"
WLD-E2	"Respect Peer Relationships"
WLD-E3	"Share Resources to Accomplish Necessary Tasks"
WLD-E4	"Facilitate the Work Ethic by Completing Tasks on Time and Accurately

INTRODUCTION:

This module will demonstrate to each student problem solving techniques necessary for all high skill workers and technicians.

PRESENTATION OUTLINE:

Students will receive information on:

1. Problem definition
2. Determining facts pertaining to this problem
3. Problem indicators
4. Major considerations pertaining to the problem
5. Affinity method
6. Pareto chart
7. Cause-effect diagrams
8. The scientific method
9. Cost-benefits method
10. Creative thinking
11. Consideration of alternatives
12. Testing of recommended solutions
13. Trial and follow-up
14. Design and experiments

PRACTICAL APPLICATION:

Problems from the workplace will be selected and defined using several problem-solving methods.

EVALUATION AND/OR VERIFICATION:

Students will make a list of the work ethics they will follow and this will be referred to instructor for evaluation or further discussion. Students will evaluate the effectiveness of work before and after team assignments.

SUMMARY:

Welders have to become knowledgeable problem solvers by the nature of their work and the expectations of their employers. Creative thinking is a must for designers and fabricators.

NEXT LESSON ASSIGNMENT:

MASTER Technical Modules (WLD-E7 and E8) dealing with supporting a positive attitude and encouraging good feelings and morale.

WLD-E5 and WLD-E6-HO
Be Involved with Problem Solving
Apply Creative Thinking
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Enable students to experience and solve problems with various methods and tools;
B. Encourage proper definition of the problem; and,
C. Understand root cause failure analysis.

MODULE OUTLINE:

Students will receive information on:

1. Problem definition
2. Determining facts pertaining to this problem
3. Problem indicators
4. Major considerations pertaining to the problem
5. Affinity method
6. Pareto chart
7. Cause-effect diagrams
8. The scientific method
9. Cost-benefits method
10. Creative thinking
11. Consideration of alternatives
12. Testing of recommended solutions
13. Trial and follow-up
14. Design and experiments

WELDER SERIES

MASTER Technical Module No. WLD-E07 and WLD-E08

SUBJECT: **WELDING TECHNICIAN** **TIME: 2 HOURS**

- **DUTY:** **WORK AS A TEAM**
- **TASK:** Support A Positive Attitude
- **TASK:** Encourage Good Feelings and Morale

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Encourage an attitude of work that is geared toward positive achievement, and,

B. Promote high morale and good feeling among the work force instead of negative attitudes that may become barriers.

INSTRUCTIONAL MATERIALS:

TEXT:

The Motivating Team Leader, Dr. Lewis E. Losoncy, Latest Edition

MASTER Handout (WLD-E7 and WLD-E8-HO)

REFERENCES:

The New Manufacturing Challenge – Techniques for Continuous Improvement, Kiyoshi Suzaki, Latest Edition
Creating Quality – Concepts, Systems, Strategies, and Tools, William J. Kolarik, Latest Edition
Quality System Requirements QS9000, Chrysler, Ford, General Motors Corporation, Latest Editions
Workplace Basics – The Essential Skills Employers Want, Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, Latest Edition
Organizational Teams – Building Continuous Quality Improvement, Peter Mears, Latest Edition
Team Excellence, Lorber Kamai Associates, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-E1	"Understand the Roles of Co-Workers"
WLD-E2	"Respect Peer Relationships"
WLD-E3	"Share Resources to Accomplish Necessary Tasks"
WLD-E4	"Facilitate the Work Ethic by Completing Tasks on Time and Accurately"
WLD-E5	"Be Involved with Problem Solving"
WLD-E6	"Apply Creative Thinking"

INTRODUCTION:

This module will demonstrate to each student that companies often succeed or fail, depending upon the feeling of trust and confidence, and feelings of potential achievement.

PRESENTATION OUTLINE:

Students will receive information on the following:

1. The basis for trust and confidence
2. Employer belief systems and outcomes in the workplace
3. Case studies where employee morale made a difference

PRACTICAL APPLICATION:

Students will example case studies that feature the significance of attitudes and feelings of employers to important outcomes.

EVALUATION AND/OR VERIFICATION:

Students will make a list of the work ethics they will follow and this will be referred to instructor for evaluation or further discussion. Students will evaluate the effectiveness of work before and after team assignments.

SUMMARY:

There are those that say that attitude and feelings are part of the company's belief systems, which are sold and traded every day in the marketplace.

NEXT LESSON ASSIGNMENT:

MASTER Technical Modules (WLD-E9 and WLD-E10) dealing with understanding purpose and goals of the organization and planning and organizing work as a team.

WLD-E7 and WLD-E8-HO
Support a Positive Attitude
Encourage Good Feelings and Morale
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Encourage an attitude of work that is geared toward positive achievement; and,

B. Promote high morale and good feeling among the work force instead of negative attitudes that may become barriers.

MODULE OUTLINE:

Students will receive information on the following:

1. The basis for trust and confidence
2. Employer belief systems and outcomes in the workplace
3. Case studies where employee morale made a difference

WELDER SERIES

MASTER Technical Module No. WLD-E09 and WLD-E10

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY**: **WORK AS A TEAM**
- **TASK**: Understand Purpose and Goals of the Organization
- **TASK**: Plan and Organize Work as a Team

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Understand the process of developing company purposes and goals; and,
B. Understand the planning and organizing of work in an organization with teams.

INSTRUCTIONAL MATERIALS:

TEXT:

The Motivating Team Leader, Dr. Lewis E. Losoncy, Latest Edition

MASTER Handout (WLD-E9 and WLD-E10-HO)

REFERENCES:

The New Manufacturing Challenge – Techniques for Continuous Improvement, Kiyoshi Suzaki, Latest Edition
Creating Quality – Concepts, Systems, Strategies, and Tools, William J. Kolarik, Latest Edition
Quality System Requirements QS9000, Chrysler, Ford, General Motors Corporation, Latest Editions
Workplace Basics – The Essential Skills Employers Want, Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, Latest Edition
Organizational Teams – Building Continuous Quality Improvement, Peter Mears, Latest Edition
Team Excellence, Lorber Kamai Associates, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-E1	"Understand the Roles of Co-Workers"
WLD-E2	"Respect Peer Relationships"

WLD-E3	“Share Resources to Accomplish Necessary Tasks”
WLD-E4	“Facilitate the Work Ethic by Completing Tasks on Time and Accurately”
WLD-E5	“Be Involved with Problem Solving”
WLD-E6	“Apply Creative Thinking”
WLD-E7	“Support a Positive Attitude”
WLD-E8	“Encourage Good Feelings and Morale”

INTRODUCTION:

This module will demonstrate to each student that the development of a company's purposes and goals is related to how it plans and organizes its work.

PRESENTATION OUTLINE:

Students will receive information on the following:

1. The goals process
2. Company vision – a shared experience
3. Purposes of the enterprise
4. Means of accountability
5. Goods, work tasks, and work teams
6. A robust enterprise
7. The house of quality

PRACTICAL APPLICATION:

Use of case studies in the subject, examining successes and failures, with possible explanations for each.

EVALUATION AND/OR VERIFICATION:

Students will make a list of the work ethics they will follow and this will be referred to instructor for evaluation or further discussion. Students will evaluate the effectiveness of work before and after team assignments.

SUMMARY:

This module examines the realities of success and failure that result from goal setting and organizing to do work.

NEXT LESSON ASSIGNMENT:

MASTER Technical Modules (WLD-E11, WLD-E12, and WLD-E13) dealing with being willing to lead in areas of knowledge and expertise, demonstrating willingness to learn new methods and skills, and demonstrating good personal relations skills.

WLD-E9 and WLD-E10-HO
Understand Purpose and Goals of the Organization
Apply Creative Thinking
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Understand the process of developing company purposes and goals; and,

B. Understand the planning and organizing of work in an organization with teams.

MODULE OUTLINE:

Students will receive information on the following:

1. The goals process
2. Company vision – a shared experience
3. Purposes of the enterprise
4. Means of accountability
5. Goods, work tasks, and work teams
6. A robust enterprise
7. The house of quality

WELDER SERIES

MASTER Technical Module No. WLD-E11, WLD-E12 & WLD-E13

SUBJECT: **WELDING TECHNICIAN** **TIME: 8 HOURS**

- **DUTY**: **WORK AS A TEAM**
- **TASK**: Be Willing to Lead in Areas of Knowledge and Expertise
- **TASK**: Demonstrate Willingness to Learn New Methods and Skills
- **TASK**: Demonstrate Good Personal Relations Skills

OBJECTIVES:

Upon completion of this module the student will be able to:

A. Understand leadership and be willing to lead in areas of knowledge and expertise;
B. Be willing to learn new methods and skills; and,
C. Understand the need for good personal relations and interpersonal skills.

INSTRUCTIONAL MATERIALS:

TEXT:

The Motivating Team Leader, Dr. Lewis E. Losoncy, Latest Edition

MASTER Handout (WLD-E11, WLD-E12, and WLD-E13-HO)

REFERENCES:

The New Manufacturing Challenge – Techniques for Continuous Improvement, Kiyoshi Suzaki, Latest Edition
Creating Quality – Concepts, Systems, Strategies, and Tools, William J. Kolarik, Latest Edition
Quality System Requirements QS9000, Chrysler, Ford, General Motors Corporation, Latest Editions
Workplace Basics – The Essential Skills Employers Want, Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, Latest Edition
Organizational Teams – Building Continuous Quality Improvement, Peter Mears, Latest Edition
Team Excellence, Lorber Kamai Associates, Latest Edition

STUDENT PREPARATION:

Students should have previously completed the following Technical Modules:

WLD-E1	"Understand the Roles of Co-Workers"
WLD-E2	"Respect Peer Relationships"
WLD-E3	"Share Resources to Accomplish Necessary Tasks"
WLD-E4	"Facilitate the Work Ethic by Completing Tasks on Time and Accurately"
WLD-E5	"Be Involved with Problem Solving"
WLD-E6	"Apply Creative Thinking"
WLD-E7	"Support a Positive Attitude"
WLD-E8	"Encourage Good Feelings and Morale"
WLD-E9	"Understand Purpose and Goals of the Organization"
WLD-E10	"Plan and Organize Work as a Team"

INTRODUCTION:

This module will demonstrate to each student that each person can and should exercise leadership potential.

PRESENTATION OUTLINE:

Students will receive information on the following:

1. Definition of leadership
2. Leadership – situations and circumstances
3. Is knowledge all there is?
4. Leadership success is related to style, meeting needs, and maintaining good interpersonal relations
5. How is leadership learned?
6. Is a good leader a role model?
7. What values does the leader need?
8. Does the leader share resources and ideas?
9. Where does the leader change?
10. Are there levels of leadership and new responsibility?
11. Can leadership be distributed?
12. Does a leader need new methods and skills?
13. How important are human relation and interpersonal skills?

PRACTICAL APPLICATION:

Situational exercises where the leader must respond. Class will determine if the response was appropriate. Leadership will change among class members.

EVALUATION AND/OR VERIFICATION:

Students will make a list of the leadership principles they will follow and this will be referred to instructor for evaluation or further discussion. Students will evaluate the effectiveness of work before and after team assignments.

SUMMARY:

To work as a team, one must often think and act as a leader. The definition of leadership may differ among individuals, but people always respect the leader and he or she respects them.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-F1) dealing with exhibiting understanding of basic arithmetic functions.

WLD-E11, WLD-E12, and WLD-E13-HO
Be Willing to Lead in Areas of Knowledge and Expertise
Demonstrate Willingness to Learn New Methods and Skills
Demonstrate Good Personal Relations Skills
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Understand leadership and be willing to lead in areas of knowledge and expertise
B. Be willing to learn new methods and skills
C. Understand the need for good personal relations and interpersonal skills

---

MODULE OUTLINE:

Students will receive information on the following:

1. Definition of leadership
2. Leadership – situations and circumstances
3. Is knowledge all there is?
4. Leadership success is related to style, meeting needs, and maintaining good interpersonal relations
5. How is leadership learned?
6. Is a good leader a role model?
7. What values does the leader need?
8. Does the leader share resources and ideas?
9. Where does the leader change?
10. Are there levels of leadership and new responsibility?
11. Can leadership be distributed?
12. Does a leader need new methods and skills?
13. How important are human relation and interpersonal skills?

512 A.

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW [illegible] and groove [illegible] on T and butt [illegible] on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDs.PM6
[illegible]

513

514

Duty F

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
M2 GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3 GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required; understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on lilfe of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1 Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2 Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES

MASTER Technical Module No. WLD-F01

SUBJECT: WELDING TECHNICIAN **TIME: 5 HOURS**

- **DUTY:** **MATHEMATICAL SKILLS**
- **TASK:** Exhibit Understanding of Basic Arithmetic Functions

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform operations and applications with real numbers;
B. Perform addition operations with whole numbers;
C. Perform subtraction operations with whole numbers;
D. Perform multiplication operations with whole numbers;
E. Perform division operations with whole numbers;
F. Utilize hand-held calculators for problem solving with whole numbers; and,
G. Understand the roots of numbers and the percent base.

INSTRUCTIONAL MATERIALS:

Technical Mathematics, Smith, Robert D., Delmar Publishers, (ISBN 0-8273-6808-9), Latest Edition
A classroom set of scientific calculators
Overhead projector
Prepared overlays
Measurement Tools
MASTER Handout (WLD-F1-HO)

REFERENCES:

Mathematical Foundations: Fundamentals, Cord Communications, Inc., Latest Edition
Mathematical Foundations: Algebra Vol. 1, Text and Teachers' Edition, Cord Communications, Inc., Latest Edition
Mathematical Foundations: Algebra Vol. II, Text and Teachers' Edition, Cord Communications, Inc., Latest Edition
Understanding Mathematics in the Plant, TPC (lesson plans, transparencies, and training guide), Latest Edition
Shop Inspection Techniques, Oak Ridge National Lab (measurement tools and activities), Latest Edition
Technical Mathematics, J. Peterson, Delmar Publishers, Latest Edition

---

STUDENT PREPARATION:

Passing scores on the math and algebra portions of the College Placement Test for degree seeking students.

INTRODUCTION:

This module teaches applied mathematics for students in the technical field. It features operations and applications with real numbers and applied statistics as tools to analyze and solve technical problems. The scientific calculator will also be used to solve problems in both the English and Metric systems.

PRESENTATION OUTLINE:

Major Topics

I. The hand-held calculator - Operations with real numbers
  A. Whole numbers
II. Estimation
  A. Addition and subtraction
  B. Multiplication and division
III. Problem solving: Using calculators
  A. Whole numbers
IV. The roots of numbers as the opposite of powers
V. The percent base and how to solve for each variable

PRACTICAL APPLICATION:

- Students will review the key symbols and functions of the calculator. With students working in groups of two or three, using both an individual and team approach, emphasize whole numbers and the concepts of place value, expanded form, rounding to estimate, and math vocabulary.
- Demonstrate the meaning of addition, subtraction, multiplication, and division with whole numbers.
- Emphasize multiplying and dividing by powers of ten. Demonstrate the roots of numbers as the opposite of powers. Review the percent base and how to solve for each variable.

EVALUATION AND/OR VERIFICATION:

The evaluation will consist of a test on this module that consists of both standard testing and physical demonstration of understanding of material.

SUMMARY:

There will be a review of each module reemphasizing the important points.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-F2) dealing with exhibiting understanding of converting fractions and decimals.

WLD-F1-HO
Exhibit Understanding of Basic Arithmetic Functions
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Perform operations and applications with real numbers;
B. Perform addition operations with whole numbers;
C. Perform subtraction operations with whole numbers;
D. Perform multiplication operations with whole numbers;
E. Perform division operations with whole numbers;
F. Utilize hand-held calculators for problem solving with whole numbers; and,
G. Understand the roots of numbers and the percent base.

MODULE OUTLINE:

Major Topics

I. The hand-held calculator - Operations with real numbers
    A. Whole numbers
II. Estimation
    A. Addition and subtraction
    B. Multiplication and division
III. Problem solving: Using calculators
    A. Whole numbers
IV. The roots of numbers as the opposite of powers
V. The percent base and how to solve for each variable

WELDER SERIES

MASTER Technical Module No. WLD-F02

SUBJECT: **WELDING TECHNICIAN** **TIME: 15 HOURS**

- **DUTY:** **MATHEMATICAL SKILLS**
- **TASK:** Exhibit Understanding of Converting Fractions and Decimals

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform operations and applications with fractions and decimals;
B. Perform addition operations with fractions and decimals;
C. Perform subtraction operations with fractions and decimals;
D. Perform multiplication operations with fractions and decimals;
E. Perform division operations with fractions and decimals; and,
F. Utilize hand-held calculators for problem solving with fractions and decimals.

INSTRUCTIONAL MATERIALS:

Technical Mathematics, Smith, Robert D., Delmar Publishers, (ISBN 0-8273-6808-9), Latest Edition
A classroom set of scientific calculators
Overhead projector
Prepared overlays
MASTER Handout (WLD-F2-HO)

REFERENCES:

Mathematical Foundations: Fundamentals, Cord Communications, Inc., Latest Edition
Mathematical Foundations: Algebra Vol. 1, Text and Teachers' Edition, Cord Communications, Inc., Latest Edition
Mathematical Foundations: Algebra Vol. II, Text and Teachers' Edition, Cord Communications, Inc., Latest Edition
Understanding Mathematics in the Plant, TPC (lesson plans, transparencies, and training guide), Latest Edition
Shop Inspection Techniques, Oak Ridge National Lab (measurement tools and activities), Latest Edition
Technical Mathematics, J. Peterson, Delmar Publishers, Latest Edition

STUDENT PREPARATION:

Passing scores on the math and algebra portions of the College Placement Test for degree seeking students.

Students should have previously completed the following Technical Modules:

WLD-F1	"Exhibit Understanding of Basic Arithmetic Functions"

INTRODUCTION:

This module teaches decimals, percentages, and applied statistics as tools to analyze and solve technical problems required for precision measurements by technicians or technologists. The scientific calculator will also be used to solve problems in both the English and Metric systems.

PRESENTATION OUTLINE:

Major Topics

I. The Hand-Held Calculator - Operations with Fractions
  A. Fractions: Percent (%) forms
II. Estimation of Fractions
  A. Addition and Subtraction
  B. Multiplication and Division
III. Problem Solving: Using Calculators
  A. Fractions: Percent (%) forms
  B. Fractions: Decimal forms

PRACTICAL APPLICATION:

1. Students will review the key symbols and functions of the calculator. With students working in groups of two or three, using both an individual and team approach, emphasize fractions and decimals and math vocabulary.
2. Demonstrate the meaning of addition, subtraction, multiplication, and division with fractions. Demonstrate estimating techniques with operations of fractions.
3. Demonstrate changing from fractions to decimals and percents and conversely.

EVALUATION AND/OR VERIFICATION:

The evaluation will consist of a test on this module that consists of both standard testing and physical demonstration of understanding of material.

SUMMARY:

There will be a review of each module reemphasizing the important points.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-F3) dealing with demonstrating practical mathematics in the use of measurement tools"

WLD-F2-HO
Exhibit Understanding of Converting Fractions and Decimals
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform operations and applications with fractions and decimals;
B. Perform addition operations with fractions and decimals;
C. Perform subtraction operations with fractions and decimals;
D. Perform multiplication operations with fractions and decimals;
E. Perform division operations with fractions and decimals; and,
F. Utilize hand-held calculators for problem solving with fractions and decimals.

MODULE OUTLINE:

Major Topics

I. The Hand-Held Calculator - Operations with Fractions
  A. Fractions: Percent (%) forms
II. Estimation of Fractions
  A. Addition and Subtraction
  B. Multiplication and Division
III. Problem Solving: Using Calculators
  A. Fractions: Percent (%) forms
  B. Fractions: Decimal forms

WELDER SERIES

MASTER Technical Module No. WLD-F03

SUBJECT: **WELDING TECHNICIAN** **TIME: 15 HOURS**

- **DUTY:** **MATHEMATICAL SKILLS**
- **TASK:** Demonstrate Practical Mathematics in the use of Measurement Tools

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand Industrial Concepts of measurement;
B. Demonstrate ability to correctly solve problem applications;
C. Understand the proper utilization of measuring tools; and,
D. Demonstrate ability to properly use measuring tools.

INSTRUCTIONAL MATERIALS:

Technical Mathematics, Smith, Robert D., Delmar Publishers, (ISBN 0-8273-6808-9), Latest Edition
Overhead projector
Prepared overlays
Scientific Calculator
Tools for each student:
    Tape Measure
    Folding Rule
    Steel Tape and Steel Rules
    Vernier and Dial Calipers
    Micrometers
MASTER Handout No. 1 (WLD-F3-HO1)
MASTER Handout No. 2 (WLD-F3-HO2)
MASTER Handout No. 3 (WLD-F3-HO3)
MASTER Handout No. 4 (WLD-F3-HO4)
MASTER Laboratory Aid (WLD-F3-LA)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2

REFERENCES:

Mathematical Foundations: Fundamentals, Cord Communications, Inc., Latest Edition

Mathematical Foundations: Algebra Vol. 1, Text and Teachers' Edition, Cord Communications, Inc., Latest Edition
Mathematical Foundations: Algebra Vol. I1, Text and Teachers' Edition, Cord Communications, Inc., Latest Edition
Understanding Mathematics in the Plant, TPC (lesson plans, transparencies, and training guide), Latest Edition
Shop Inspection Techniques, Oak Ridge National Lab (measurement tools and activities), Latest Edition
Technical Mathematics, J. Peterson, Delmar Publishers, Latest Edition

---

STUDENT PREPARATION:

Passing scores on the math and algebra portions of the College Placement Test for degree seeking students.

Students should have previously completed the following Technical Modules:

WLD-F1	"Exhibit Understanding of Basic Arithmetic Functions"
WLD-F2	"Exhibit Understanding of Converting Fractions and Decimals"

INTRODUCTION:

This module teaches the use of applied mathematics with measurement tools in the technical field. Measurement tools needed for precision measurements by technicians or technologists will be featured. The scientific calculator will also be used to solve problems in both the English and Metric systems.

PRESENTATION OUTLINE:

Major Topics

I. Industrial Concepts of Measurement
  A. Approximate and Exact Numbers
  B. Precision
  C. Accuracy
  D. Tolerance
  E. Significant Numbers
  F. Absolute and Relative Error
  G. Problem Solving Applications
II. Measuring Tools and Problem Solving
  A. Tape Measure
  B. Steel Tape
  C. Vernier Caliper
  D. Micrometers

PRACTICAL APPLICATION:

1. Discuss and illustrate differences between exact and approximate numbers. Illustrate, by using measurements, the concepts of both precision, significant digits, and accuracy.
2. Show examples of common linear measuring instruments and involve class in discussion on applications of these instruments.
3. Illustrate how to find the degree of precision when adding or subtracting measurements.
4. List and apply rules for determining significant digits.
5, Demonstrate, using a range of examples, the concept of accuracy and absolute and relative error
6. Demonstrate the concept of tolerance, both unilateral and bilateral as well as the concept of interference fit.
7. Have class practice performing selected measures with both an English and metric rule.
8. Demonstrate the use of Vernier and Dial Calipers and have class perform selected measurements to indicate understanding.
9. Demonstrate micrometers and have class perform selected measurements to indicate understanding.

EVALUATION AND/OR VERIFICATION:

The evaluation will consist of a test on this module that consists of both standard testing and physical demonstration of understanding of material.

SUMMARY:

There will be a review of each module reemphasizing the important points.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-F4) dealing with interconverting Metric/English measurements.

WLD-F3-HO1

Demonstrate Practical Mathematics in the Use of Measurement Tools

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand Industrial Concepts of measurement;
B. Demonstrate ability to correctly solve problem applications;
C. Understand the proper utilization of measuring tools; and,
D. Demonstrate ability to properly use measuring tools.

MODULE OUTLINE:

Major Topics

I. Industrial Concepts of Measurement
    A. Approximate and Exact Numbers
    B. Precision
    C. Accuracy
    D. Tolerance
    E. Significant Numbers
    F. Absolute and Relative Error
    G. Problem Solving Applications
II. Measuring Tools and Problem Solving
    A. Tape Measure
    B. Steel Tape
    C. Vernier Caliper
    D. Micrometers

WLD-F3-HO2
Demonstrate Practical Mathematics in the Use of Measurement Tools
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the use of metrology in manufacturing;
b. Discuss the Inch system of measurement;
c. Discuss the Metric system of measurement;
d. Discuss semi-precision and precision measurement; and,
e. Discuss the following: precision, reliability, discrimination, and accuracy.

MODULE OUTLINE:

I. Discuss the Use of Metrology in Manufacturing
  A. Discuss the function and reason for measurements in manufacturing
  B. Discuss the changes (metrology related) in manufacturing today
    1. Interchangeable manufacture
    2. World trade
    3. High precision
II. Discuss the Inch System of Measurement
  A. Discuss fractional (scale) dimensions for linear measurement
  B. Discuss decimal dimensions for linear measurement
  C. Convert fractional to decimal
    1. Review mathematical conversion method
    2. Fractional/decimal conversion charts
  D. Practice and demonstration of skills listed above
III. Discuss the Metric System of Measurement
  A. Discuss the units of measure commonly used in the metric system
  B. Convert inch to metric
    1. Review mathematical method (1 inch = 25.4 mm)
    2. Conversion charts
  C. Practice and demonstration of skills listed above
IV. Discuss Semi-Precision and Precision Measurement
  A. Discuss the difference between semi-precision and precision measurement
    1. Semi-precision measurements are 1/64" (.5mm) or greater
    2. Precision measurements are less than 1/64" (.5mm)
  B. Discuss the five categories of precision measurement
    1. Outside measurement
    2. Inside measurement
    3. Depth measurement
    4. Thread measurement
    5. Height measurement

V. *Discuss the Following Measurement Terms: Accuracy, Precision, Reliability, and* Discrimination

- A. *Accuracy* - whether or not something is made according to standard. (The standard for manufacturing is the blueprint.)
- B. *Precision* - the degree of exactness required for an application or design requirement
- C. *Reliability* - the ability to consistently obtain the desired result
- D. *Discrimination* - the degree that a measuring instrument divides its basic unit of length

WLD-F3-HO3

Demonstrate Practical Mathematics in the Use of Measurement Tools

Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Identify basic semi-precision measuring tools;
b. Identify precision measuring tools;
c. Justify use of particular measurement tools based on tool characteristics;
d. Identify error possibilities in measurement tool selection; and,
e. Demonstrate proper care of precision measuring tools.

MODULE OUTLINE:

I. Describe and Discuss the Following Semi-Precision Measuring Tools
   A. Steel rules
   B. Calipers
   C. Squares
II. Describe and Discuss the Following Precision Measuring Tools
   A. Micrometers (outside, inside and depth)
   B. Verniers (calipers and height gage)
   C. Gages (small hole, telescope, fixed, and dial bore)
III. Justify Use of Particular Measurement Tools Based on Tool Characteristics
   A. What tolerance is required by the print?
   B. What physical characteristics of the part influence tool selection?
   C. What is the discrimination of the tool?
   D. How much time is available for part measurement/inspection?
   E. Will the tool be used by itself or in conjunction with some other tool?
   F. What is the most reliable tool for this application?
IV. Identify Error Possibilities in Measurement Tool Selection
   A. Part not being produced to specifications
   B. Too much time spent trying to measure correctly by not having the right tool
V. Demonstrate Proper Care of Precision Measuring Tools
   A. Storage
   B. Handling
   C. Cleaning

WLD-F3-HO4

Demonstrate Practical Mathematics in the Use of Measurement Tools

Attachment 4: **MASTER** Handout No. 4

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Measure with steel rules (metric and inch);
b. Measure with micrometers;
c. Measure with comparison measuring instruments (e.g., calipers, telescope gages);
d. Measure with direct measuring instruments (e.g., vernier, dial and digital instruments); and,
e. Measure with fixed gages (go and no-go gages).

MODULE OUTLINE:

I. Discuss the Importance of Learning and Practicing Proper Measurement Techniques
  A. Show the video "Measuring Tools"
  B. Give each student a copy of the handout "Proper Measuring Techniques"
II. Discuss and Demonstrate Proper Measurement Techniques Using the Steel Rule
III. Discuss and Demonstrate the Use of Micrometer Type Measuring Instruments
  A. Outside micrometers
  B. Inside micrometers
  C. Depth micrometers
  D. Practice and demonstration of skills listed above
IV. Discuss and Demonstrate the Use of Transfer Type Measuring Instruments
  A. Spring calipers (inside and outside)
  B. Telescope gages
  C. Small hole gages
  D. Practice and demonstration of skills listed above
V. Discuss and Demonstrate the Use of Direct Measuring Instruments
  A. Vernier calipers
  B. Dial calipers
  C. Digital calipers
  D. Practice and demonstration of skills listed above
VI. Discuss the Purpose of Fixed Gages and Demonstrate Their Use
  A. Cylindrical plug and ring gages
  B. Taper plug and ring gages
  C. Snap gages
  D. Thread plug gages
  E. Practice and demonstration of skills listed above
VII. Complete Practical Exercises on all above material

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated
2. Do not talk to anyone who is operating a machine
3. Walk only in the designated traffic lanes
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules

Name ______________________________ Date ______________________

WLD-F3
Demonstrate Practical Mathematics in the Use of Measurement Tools
Self-Assessment No. 1

Circle the best answer

1. Which of the following is not a term for the science of measuring?
   - A. Calibration
   - B. Comparison
   - C. Measurology
   - D. Metrology

2. Name two systems of measurement presently used in the United States.
   - A. Fractions and decimals
   - B. Metric and inch
   - C. Precision and non-precision
   - D. Inside and outside

3. What is the most common inch to metric conversion factor in use today?
   - A. 1" = 25.4mm
   - B. lmm = .25.4"
   - C. 1'= 12mm
   - D. 1/16" = 64mm

4. Precision measurement can be defined as any measurement made to a degree finer than:
   - A. 1/8"
   - B. 1/16"
   - C. 1/32"
   - D. 1/64"

5. Precision measurement can also be defined as any measurement made to a degree finer than:
   - A. .25mm.
   - B. .5mm.
   - C. . l0mm.
   - D. 3.24mm.

6. __________ in metrology refers to whether or not a specific measurement is actually within its stated size.
A. Precision
B. Reliability
C. Discrimination
D. Accuracy

7. __________ in metrology is relative to the specific measurement being made, with regard to the degree of exactness required.
A. Precision
B. Reliability
C. Discrimination
D. Accuracy

8. __________ in metrology refers to the degree to which a measuring instrument divides the basic unit of length it is using for measurement.
A. Precision
B. Reliability
C. Discrimination
D. Accuracy

9. __________ in metrology refers to the ability to obtain the desired result to the degree of precision required.
A. Precision
B. Reliability
C. Discrimination
D. Accuracy

10. The five categories of precision measurement are outside, inside, length, depth, and:
A. Taper
B. Rpm
C. Thread
D. Rms

WLD-F3
Demonstrate Practical Mathematics in the Use of Measurement Tools
Self-Assessment No. 1 Answer Key

1.	b
2.	b
3.	a
4.	d
5.	b
6.	d
7.	a
8.	c
9.	b
10.	c

Name ______________________________ Date ____________________

WLD-F3
Demonstrate Practical Mathematics in the Use of Measurement Tools
Self-Assessment No. 2

Circle the best answer.

1. A __________ is a linear measuring instrument whose graduations represent real units of length.
   - A. Steeltape
   - B. Scale
   - C. Rule
   - D. Yardstick

2. A vernier caliper has two scales: the vernier scale and the __________
   - A. Top scale
   - B. Main scale
   - C. Principle scale
   - D. Inside scale

3. What is the discrimination for vernier instruments used for Linear measurement?
   - A. .001"
   - B. .02mm
   - C. 1/64"
   - D. A and B above

4. How are metric scales usually graduated?
   - A. Meters
   - B. Feet and inches
   - C. Milliliters
   - D. MM and.5mm

5. The technician combination set includes 4 components: the steel rule, the protractor head, the square head, and __________
   - A. Magnetic base
   - B. Protective cover
   - C. Center head
   - D. Adjustable depth gage

WELDER SERIES

MASTER Technical Module No. WLD-F04

SUBJECT: **WELDING TECHNICIAN** **TIME: 15 HOURS**

- **DUTY:** **MATHEMATICAL SKILLS**
- **TASK:** Inter-Convert Metric/English Measurements

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the concepts of ratios;
B. Understand the concepts of proportions;
C. Understand the concepts of measures (linear, area, capacity, weight);
D. Show proficiency in the English system;
E. Show proficiency in the Metric system;
F. Understand Integers; and,
G. Demonstrate ability to solve problems in these areas.

INSTRUCTIONAL MATERIALS:

Technical Mathematics, Smith, Robert D., Delmar Publishers,
(ISBN 0-8273-6808-9), Latest Edition
Overhead projector
Prepared overlays
Scientific Calculator
Tools for each student:
    Tape Measure
    Folding Rule
    Steel Tape and Steel Rules
    Vernier and Dial Calipers
    Micrometers
MASTER Handout No. 1 (WLD-F4-HO1)
MASTER Handout No. 2 (WLD-F4-HO2)
MASTER Handout No. 3 (WLD-F4-HO3)
MASTER Handout No. 4 (WLD-F4-HO4)
MASTER Laboratory Aid (WLD-F4-LA)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2

REFERENCES:

Mathematical Foundations: Fundamentals, Cord Communications, Inc., Latest Edition
Mathematical Foundations: Algebra Vol. 1, Text and Teachers' Edition, Cord Communications, Inc., Latest Edition
Mathematical Foundations: Algebra Vol. II, Text and Teachers' Edition, Cord Communications, Inc., Latest Edition
Understanding Mathematics in the Plant, TPC (lesson plans, transparencies, and training guide), Latest Edition
Shop Inspection Techniques, Oak Ridge National Lab (measurement tools and activities), Latest Edition
Technical Mathematics, J. Peterson, Delmar Publishers, Latest Edition

STUDENT PREPARATION:

Passing scores on the math and algebra portions of the College Placement Test for degree seeking students.

Students should have previously completed the following Technical Modules:

WLD-F1	"Exhibit Understanding of Basic Arithmetic Functions"
WLD-F2	"Exhibit Understanding of Converting Fractions and Decimals"
WLD-F3	"Demonstrate Practical Mathematics in the use of Measurement Tools"

INTRODUCTION:

This module will teach metric/English terms used for ratios, proportions, linear, area measures, capacities and weights. The module also includes instruction in measurement tools and test equipment required for precision measurements by technicians or technologists. The scientific calculator will also be used to solve problems in both the English and Metric systems.

PRESENTATION OUTLINE:

Major Topics

I. The Concept of Ratios
  A. A numerical Comparison
  B. Percent as a Ratio
  C. Equivalent Fractions
  D. Problem Solving Applications
II. The Concept of Proportions
  A. The Equality of Ratios
  B. Direct Relationships
  C. Inverse Relationships

- D. Problem Solving Applications
- III. Measurement Concepts: Selecting/Counting/Units
  - A. Linear Measures
  - B. Area Measures
  - C. Capacity Measures
  - D. Weight Measures
- IV. The English System
- V. The Metric System
- VI. Problem Solving Applications
- VII. The Integers
  - A. The meaning of Signed Numbers
  - B. The Real Number Line Graph
  - C. Operations with Integers
  - D. Problem Solving Applications

PRACTICAL APPLICATION:

1. Define and illustrate ratio and proportion and demonstrate proper set-up of ratios.
2. Problem solve for missing numerators or denominators. Illustrate direct and inverse relationships.
3. Select appropriate units for selected measures. Effectively utilize the English and Metric systems.
4. Solve measurement problems involving compound and complex compound units.
5. Define meaning of/demonstrate understanding of signed numbers, integers, and real number line graphs.

EVALUATION AND/OR VERIFICATION:

The evaluation will consist of a test on this module that consists of both standard testing and physical demonstration of understanding of material.

SUMMARY:

There will be a review of each module reemphasizing the important points.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-F5) dealing with performing practical mathematical applications relevant to area of work.

WLD-F4-HO1
Inter-Convert Metric/English Measurements
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- A. Understand the concepts of ratios;
- B. Understand the concepts of proportions;
- C. Understand the concepts of measures (linear, area, capacity, weight);
- D. Show proficiency in the English system;
- E. Show proficiency in the Metric system;
- F. Understand Integers; and,
- G. Demonstrate ability to solve problems in these areas.

MODULE OUTLINE:

Major Topics

- I. The Concept of Ratios
  - A. A numerical Comparison
  - B. Percent as a Ratio
  - C. Equivalent Fractions
  - D. Problem Solving Applications
- II. The Concept of Proportions
  - A. The Equality of Ratios
  - B. Direct Relationships
  - C. Inverse Relationships
  - D. Problem Solving Applications
- III. Measurement Concepts: Selecting/Counting/Units
  - A. Linear Measures
  - B. Area Measures
  - C. Capacity Measures
  - D. Weight Measures
- IV. The English System
- V. The Metric System
- VI. Problem Solving Applications
- VII. The Integers
  - A. The meaning of Signed Numbers
  - B. The Real Number Line Graph
  - C. Operations with Integers
  - D. Problem Solving Applications

WLD-F4-HO2
Inter-Convert Metric/English Measurements
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the use of metrology in manufacturing;
b. Discuss the Inch system of measurement;
c. Discuss the Metric system of measurement;
d. Discuss semi-precision and precision measurement; and,
e. Discuss the following: precision, reliability, discrimination, and accuracy.

MODULE OUTLINE:

I. Discuss the Use of Metrology in Manufacturing
    A. Discuss the function and reason for measurements in manufacturing
    B. Discuss the changes (metrology related) in manufacturing today
        1. Interchangeable manufacture
        2. World trade
        3. High precision
II. Discuss the Inch System of Measurement
    A. Discuss fractional (scale) dimensions for linear measurement
    B. Discuss decimal dimensions for linear measurement
    C. Convert fractional to decimal
        1. Review mathematical conversion method
        2. Fractional/decimal conversion charts
    D. Practice and demonstration of skills listed above
III. Discuss the Metric System of Measurement
    A. Discuss the units of measure commonly used in the metric system
    B. Convert inch to metric
        1. Review mathematical method (1 inch = 25.4 mm)
        2. Conversion charts
C. Practice and demonstration of skills listed above
IV. Discuss Semi-Precision and Precision Measurement
    A. Discuss the difference between semi-precision and precision measurement
        1. Semi-precision measurements are 1/64" (.5mm) or greater
        2. Precision measurements are less than 1/64" (.5mm)
    B. Discuss the five categories of precision measurement
        1. Outside measurement
        2. Inside measurement
        3. Depth measurement
        4. Thread measurement
        5. Height measurement

V. Discuss the Following Measurement Terms: Accuracy, Precision, Reliability, and Discrimination
   A. *Accuracy* - whether or not something is made according to standard. (The standard for manufacturing is the blueprint.)
   B. *Precision* - the degree of exactness required for an application or design requirement
   C. *Reliability* - the ability to consistently obtain the desired result
   D. *Discrimination* - the degree that a measuring instrument divides its basic unit of length

WLD-F4-HO3
Inter-Convert Metric/English Measurements
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Identify basic semi-precision measuring tools;
b. Identify precision measuring tools;
c. Justify use of particular measurement tools based on tool characteristics;
d. Identify error possibilities in measurement tool selection; and,
e. Demonstrate proper care of precision measuring tools.

MODULE OUTLINE:

I. Describe and Discuss the Following Semi-Precision Measuring Tools
  A. Steel rules
  B. Calipers
  C. Squares
II. Describe and Discuss the Following Precision Measuring Tools
  A. Micrometers (outside, inside and depth)
  B. Verniers (calipers and height gage)
  C. Gages (small hole, telescope, fixed, and dial bore)
III. Justify Use of Particular Measurement Tools Based on Tool Characteristics
  A. What tolerance is required by the print?
  B. What physical characteristics of the part influence tool selection?
  C. What is the discrimination of the tool?
  D. How much time is available for part measurement/inspection?
  E. Will the tool be used by itself or in conjunction with some other tool?
  F. What is the most reliable tool for this application?
IV. Identify Error Possibilities in Measurement Tool Selection
  A. Part not being produced to specifications
  B. Too much time spent trying to measure correctly by not having the right tool
V. Demonstrate Proper Care of Precision Measuring Tools
  A. Storage
  B. Handling
  C. Cleaning

WLD-F4-HO4
Inter-Convert Metric/English Measurements
Attachment 4: **MASTER** Handout No. 4

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Measure with steel rules (metric and inch);
b. Measure with micrometers;
c. Measure with comparison measuring instruments (e.g., calipers, telescope gages);
d. Measure with direct measuring instruments (e.g., vernier, dial and digital instruments); and,
e. Measure with fixed gages (go and no-go gages).

MODULE OUTLINE:

I. Discuss the Importance of Learning and Practicing Proper Measurement Techniques
  A. Show the video "Measuring Tools"
  B. Give each student a copy of the handout "Proper Measuring Techniques"
II. Discuss and Demonstrate Proper Measurement Techniques Using the Steel Rule
III. Discuss and Demonstrate the Use of Micrometer Type Measuring Instruments
  A. Outside micrometers
  B. Inside micrometers
  C. Depth micrometers
  D. Practice and demonstration of skills listed above
IV. Discuss and Demonstrate the Use of Transfer Type Measuring Instruments
  A. Spring calipers (inside and outside)
  B. Telescope gages
  C. Small hole gages
  D. Practice and demonstration of skills listed above
V. Discuss and Demonstrate the Use of Direct Measuring Instruments
  A. Vernier calipers
  B. Dial calipers
  C. Digital calipers
  D. Practice and demonstration of skills listed above
VI. Discuss the Purpose of Fixed Gages and Demonstrate Their Use
  A. Cylindrical plug and ring gages
  B. Taper plug and ring gages
  C. Snap gages
  D. Thread plug gages
  E. Practice and demonstration of skills listed above
VII. Complete Practical Exercises on all above material

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated
2. Do not talk to anyone who is operating a machine
3. Walk only in the designated traffic lanes
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules

Name ______________________________ Date ____________________

WLD-F4
Inter-Convert Metric/English Measurements
Self-Assessment No. 1

Circle the best answer

1. Which of the following is not a term for the science of measuring?
   - A. Calibration
   - B. Comparison
   - C. Measurology
   - D. Metrology

2. Name two systems of measurement presently used in the United States.
   - A. Fractions and decimals
   - B. Metric and inch
   - C. Precision and non-precision
   - D. Inside and outside

3. What is the most common inch to metric conversion factor in use today?
   - A. 1" = 25.4mm
   - B. lmm = .25.4"
   - C. 1'= 12mm
   - D. 1/16" = 64mm

4. Precision measurement can be defined as any measurement made to a degree finer than:
   - A. 1/8"
   - B. 1/16"
   - C. 1/32"
   - D. 1/64"

5. Precision measurement can also be defined as any measurement made to a degree finer than:
   - A. .25mm.
   - B. .5mm.
   - C. . l0mm.
   - D. 3.24mm.

6. __________ in metrology refers to whether or not a specific measurement is actually within its stated size.
   A. Precision
   B. Reliability
   C. Discrimination
   D. Accuracy

7. __________ in metrology is relative to the specific measurement being made, with regard to the degree of exactness required.
   A. Precision
   B. Reliability
   C. Discrimination
   D. Accuracy

8. __________ in metrology refers to the degree to which a measuring instrument divides the basic unit of length it is using for measurement.
   A. Precision
   B. Reliability
   C. Discrimination
   D. Accuracy

9. __________ in metrology refers to the ability to obtain the desired result to the degree of precision required.
   A. Precision
   B. Reliability
   C. Discrimination
   D. Accuracy

10. The five categories of precision measurement are outside, inside, length, depth, and:
    A. Taper
    B. Rpm
    C. Thread
    D. Rms

WLD-F4
Inter-Convert Metric/English Measurements
Self-Assessment No. 1 Answer Key

1. b

2. b

3. a

4. d

5. b

6. d

7. a

8. c

9. b

10. c

Name ______________________________ Date ____________________

WLD-F4
Inter-Convert Metric/English Measurements
Self-Assessment No. 2

Circle the best answer.

1. A __________ is a linear measuring instrument whose graduations represent real units of length.
   A. Steeltape
   B. Scale
   C. Rule
   D. Yardstick

2. A vernier caliper has two scales: the vernier scale and the __________
   A. Top scale
   B. Main scale
   C. Principle scale
   D. Inside scale

3. What is the discrimination for vernier instruments used for Linear measurement?
   A. .001"
   B. .02mm
   C. 1/64"
   D. A and B above

4. How are metric scales usually graduated?
   A. Meters
   B. Feet and inches
   C. Milliliters
   D. MM and.5mm

5. The technician combination set includes 4 components: the steel rule, the protractor head, the square head, and __________
   A. Magnetic base
   B. Protective cover
   C. Center head
   D. Adjustable depth gage

WELDER SERIES

MASTER Technical Module No. WLD-F05

SUBJECT: **WELDING TECHNICIAN** **TIME: 20 HOURS**

- **DUTY:** **MATHEMATICAL SKILLS**
- **TASK:** Perform Practical Mathematical Applications Relevant to Area of Work

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate proficiency in algebraic operations;
B. Understand Laws of Exponents;
C. Understand Scientific Notation;
D. Solve basic equations;
E. Solve formulas through substitution and with variables;
F. Solve linear equations;
G. Understand the systems of linear equations;
H. Understand the basic concepts of Trigonometry such as:
  - Ratios and right angles;
  - naming trigonometric ratios;
  - Functions for given angles and Angles for given functions;
  - Proficiency in calculator usage to solve trig functions;
I. Understand right triangle applications;
J. Understand and solve problems in angular measures;
K. Understand and solve problems with circles;
L. Understand and solve problems with geometric shapes; and,
M. Understand and solve problems with geometric solids.

INSTRUCTIONAL MATERIALS:

Technical Mathematics, Smith, Robert D., Delmar Publishers,
(ISBN 0-8273-6808-9), Latest Edition
Overhead projector
Prepared overlays
Scientific Calculator
Set of hands-on equation activities
Graph paper for class use
MASTER Handout (WLD-F5-HO)

REFERENCES:

Mathematical Foundations: Fundamentals, Cord Communications, Inc., Latest Edition

Mathematical Foundations: Algebra Vol. 1, Text and Teachers' Edition, Cord Communications, Inc., Latest Edition

Mathematical Foundations: Algebra Vol. I1, Text and Teachers' Edition, Cord Communications, Inc., Latest Edition

Understanding Mathematics in the Plant, TPC (lesson plans, transparencies, and training guide), Latest Edition

Shop Inspection Techniques, Oak Ridge National Lab (measurement tools and activities), Latest Edition

Technical Mathematics, J. Peterson, Delmar Publishers, Latest Edition

STUDENT PREPARATION:

Passing scores on the math and algebra portions of the College Placement Test for degree seeking students.

Students should have previously completed the following Technical Modules:

WLD-F1	"Exhibit Understanding of Basic Arithmetic Functions"
WLD-F2	"Exhibit Understanding of Converting Fractions and Decimals"
WLD-F3	"Demonstrate Practical Mathematics in the use of Measurement Tools"
WLD-F4	"Inter-Convert Metric/English Measurements"

INTRODUCTION:

This module presents algebraic functions, geometry, graphs, fundaments of trigonometry, and applied statistics as tools to analyze and solve technical problems. Module also includes instruction in measurement tools and test equipment required for precision measurements by technicians or technologists. The scientific calculator will also be used to solve problems in both the English and Metric systems.

PRESENTATION OUTLINE:

Major Topics

I. Algebraic Operations
  A. Addition of Algebraic Expressions
  B. Subtraction of Algebraic Expressions
  C. Multiplication of Algebraic Expressions
  D. Division of Algebraic Expressions
  E. Problem Solving Applications
II. Laws of Exponents
  A. Multiplication

- B. Division

III. Scientific Notation

IV. Solving Equations: Introduction
  - A. Addition/Subtraction Principles
  - B. Multiplication/Division Principles
  - C. Combined Operations
  - D. Problem Solving Applications

V. Solving Formulas: Introduction
  - A. Substitution
  - B. Solving for a Variable
  - C. Problem Solving Applications

VI. Solving Linear Equations
  - A. The Coordinate Plane
  - B. Locating Points: Ordered Pairs
  - C. Graphing Procedures
  - D. Slope/Intercept
  - E. Problem Solving Applications

VII. Solving Systems of Linear Equations
  - A. Graphing Procedures
  - B. Substitution Procedures
  - C. Elimination of a Variable
  - D. Problem Solving Applications

VIII. Introductory Trigonometry
  - A. Ratios and Right Angles
  - B. Naming Trigonometric Ratios
  - C. Functions for Given Angles
  - D. Angles for Given Functions
  - E. Calculator Skills with Trig Functions
  - F. Problem Solving Applications

IX. The Right Triangle-Applications
  - A. Ratios and Proportions
  - B. Problem Solving Techniques
  - C. Problem Solving Applications

X. Angular Measures
  - A. The Protractor/Units
  - B. Naming Angles/Triangles
  - C. The Pythagorean Theorem
  - D. Complimentary/Supplementary Angles
  - E. Problem Solving Applications

XI. The Circle
  - A. Properties of Circles - Common Terms
  - B. Circumference
  - C. Arc Length/Cords/Tangents
  - D. Problem Solving Applications

XII. Geometric Shapes - Area Measures

- A. The Circle: Sectors and Segments
- B. The Ellipse
- C. Common Polygons
- D. Problem Solving Applications

XIII. Geometric Solids: Surface Area, Volume, and Weights

- A. Cylinders and Prisms
- B. Cones and Pyramids
- C. Spheres and Composite Solids
- D. Problem Solving Applications

PRACTICAL APPLICATION:

1. Discuss concepts and provide examples of algebraic terms, like and unlike terms, literal terms, factors, and numerical coefficient and their differences.
2. Demonstrate and establish procedures for the addition, subtraction, multiplication, and division of algebraic terms.
3. Discuss the concept of powers and roots and clarify the relationship between each.
4. Provide class activity with examples of laws of exponents.
5. Demonstrate procedures for proper order of operations in mathematical formulas.
6. Introduce the concept of scientific notation and procedures for multiplying/dividing by powers of ten.
7. Practice solving mathematical sentences and translating from verbal to mathematical equations.
8. Construct the Cartesian coordinate system using provided graph paper and locate ordered pairs.
9. Demonstrate the concepts of origin, x-axis/coordinate, y-axis/coordinate, quadrants, and ordered pairs.
10. Demonstrate the procedure for constructing the graph of a linear equation and explaining the ratio of rise over run.
11. Explain the slope of a linear equation may be positive, negative, zero, or undefined and express the general equation for slope-intercept. Construct graphs from equation.
12. Demonstrate procedures for solving a system of two linear equations.
13. Draw a right triangle and have class label and name the sides of triangle.
14. Demonstrate the six basic ratios and their names by comparing the lengths of two sides.
15. Explain the numerical value of a ratio.
16. Demonstrate trigonometric functions on calculators and problem solve values of given angles and how to find angles when given values.
17. The student will acquire the necessary knowledge and skills to:
    - Use protractor to measure a given angle
    - Define the Pythagorean Theorem
    - Identify acute, obtuse, and right angles
    - Identify right, isosceles, and equilateral triangles
    - Define and illustrate the common terms associated with a circle
    - Demonstrate skill in finding the area of a given circle, common polygons,

cylinders, prisms, cones, spheres, and solids.

- Demonstrate skill in finding the weight and/or capacity of cylinders and prisms.
- Demonstrate problem solving skills involving Circles, Angles, Shapes and Solids.
- Demonstrate problem solving skills involving area, surface area, volume, capacity, and weight.

EVALUATION AND/OR VERIFICATION:

The evaluation will consist of a test on this module that consists of both standard testing and physical demonstration of understanding of material.

SUMMARY:

There will be a review of each module reemphasizing the important points.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-F6) dealing with using applied statistics, graphs, and charts for purpose of analysis and problem-solving.

WLD-F5-HO
Perform Practical Mathematical Applications Relevant to Area of Work
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate proficiency in algebraic operations;
B. Understand Laws of Exponents;
C. Understand Scientific Notation;
D. Solve basic equations;
E. Solve formulas through substitution and with variables;
F. Solve linear equations;
G. Understand the systems of linear equations;
H. Understand the basic concepts of Trigonometry such as:
  - Ratios and right angles;
  - naming trigonometric ratios;
  - Functions for given angles and Angles for given functions;
  - Proficiency in calculator usage to solve trig functions;

I. Understand right triangle applications;
J. Understand and solve problems in angular measures;
K. Understand and solve problems with circles;
L. Understand and solve problems with geometric shapes; and,
M. Understand and solve problems with geometric solids.

MODULE OUTLINE:

Major Topics

I. Algebraic Operations
  A. Addition of Algebraic Expressions
  B. Subtraction of Algebraic Expressions
  C. Multiplication of Algebraic Expressions
  D. Division of Algebraic Expressions
  E. Problem Solving Applications

II. Laws of Exponents
  A. Multiplication
  B. Division

III. Scientific Notation
IV. Solving Equations: Introduction
  A. Addition/Subtraction Principles
  B. Multiplication/Division Principles
  C. Combined Operations
  D. Problem Solving Applications

V. Solving Formulas: Introduction
    A. Substitution
    B. Solving for a Variable
    C. Problem Solving Applications
VI. Solving Linear Equations
    A. The Coordinate Plane
    B. Locating Points: Ordered Pairs
    C. Graphing Procedures
    D. Slope/Intercept
    E. Problem Solving Applications
VII. Solving Systems of Linear Equations
    A. Graphing Procedures
    B. Substitution Procedures
    C. Elimination of a Variable
    D. Problem Solving Applications
VIII. Introductory Trigonometry
    A. Ratios and Right Angles
    B. Naming Trigonometric Ratios
    C. Functions for Given Angles
    D. Angles for Given Functions
    E. Calculator Skills with Trig Functions
    F. Problem Solving Applications
IX. The Right Triangle-Applications
    A. Ratios and Proportions
    B. Problem Solving Techniques
    C. Problem Solving Applications
X. Angular Measures
    A. The Protractor/Units
    B. Naming Angles/Triangles
    C. The Pythagorean Theorem
    D. Complimentary/Supplementary Angles
    E. Problem Solving Applications
XI. The Circle
    A. Properties of Circles - Common Terms
    B. Circumference
    C. Arc Length/Cords/Tangents
    D. Problem Solving Applications
XII. Geometric Shapes - Area Measures
    A. The Circle: Sectors and Segments
    B. The Ellipse
    C. Common Polygons
    D. Problem Solving Applications
XIII. Geometric Solids: Surface Area, Volume, and Weights
    A. Cylinders and Prisms
    B. Cones and Pyramids

C. Spheres and Composite Solids
D. Problem Solving Applications

WELDER SERIES

MASTER Technical Module No. WLD-F06

SUBJECT: **WELDING TECHNICIAN** **TIME: 5 HOURS**

- **DUTY:** **MATHEMATICAL SKILLS**
- **TASK:** Use Applied Statistics, Graphs, and Charts for Purpose of Analysis and Problem Solving

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the interpretation of graphs; and,

B. Construct various graphs.

INSTRUCTIONAL MATERIALS:

Technical Mathematics, Smith, Robert D., Delmar Publishers, (ISBN 0-8273-6808-9), Latest Edition
Overhead projector
Prepared overlays
Scientific Calculator
Graph paper
MASTER Handout (WLD-F6-HO)

REFERENCES:

Mathematical Foundations: Fundamentals, Cord Communications, Inc., Latest Edition
Mathematical Foundations: Algebra Vol. 1, Text and Teachers' Edition, Cord Communications, Inc., Latest Edition
Mathematical Foundations: Algebra Vol. I1, Text and Teachers' Edition, Cord Communications, Inc., Latest Edition
Understanding Mathematics in the Plant, TPC (lesson plans, transparencies, and training guide), Latest Edition
Shop Inspection Techniques, Oak Ridge National Lab (measurement tools and activities), Latest Edition
Technical Mathematics, J. Peterson, Delmar Publishers, Latest Edition

STUDENT PREPARATION:

Passing scores on the math and algebra portions of the College Placement Test for degree seeking students.

Students should have previously completed the following Technical Modules:

WLD-F1	"Exhibit Understanding of Basic Arithmetic Functions"
WLD-F2	"Exhibit Understanding of Converting Fractions and Decimals"
WLD-F3	"Demonstrate Practical Mathematics in the use of Measurement Tools"
WLD-F4	"Inter-Convert Metric/English Measurements"
WLD-F5	"Perform Practical Mathematical Applications Relevant to Area of Work"

INTRODUCTION:

This module teaches applied statistics for graphs, charts, and tools for analysis and problem solving.

PRESENTATION OUTLINE:

Major Topics

I. The Interpretation of Graphs
   A. The Purpose of Graphs
   B. The Structure of Graphs
   C. Reading Graphs
II. The Construction of Graphs
   A. Bar Graphs
   B. Line Graphs
   C. Broken-Line Graphs
   D. Curve-Line Graphs
   E. Problem Solving Applications

PRACTICAL APPLICATION:

The student will acquire the necessary knowledge and skills to:

- Demonstrate skill in reading selected line graphs
- Demonstrate skill in constructing Vertical and Horizontal Bar Graphs
- Demonstrate skill in constructing Broken Line, Straight Line, and Curve Line Graphs
- Demonstrate skill in problem solving with bar and line graphs

EVALUATION AND/OR VERIFICATION:

The evaluation will consist of a test on this module that consists of both standard testing and physical demonstration of understanding of material.

SUMMARY:

There will be a review of each module reemphasizing the important points.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-G1) dealing with reading job method plan.

WLD-F6-HO
Use Applied Statistics, Graphs, and Charts For Purpose of Analysis and Problem Solving
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the interpretation of graphs; and,
B. Construct various graphs.

MODULE OUTLINE:

Major Topics

I. The Interpretation of Graphs
  A. The Purpose of Graphs
  B. The Structure of Graphs
  C. Reading Graphs
II. The Construction of Graphs
  A. Bar Graphs
  B. Line Graphs
  C. Broken-Line Graphs
  D. Curve-Line Graphs
  E. Problem Solving Applications

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

	Duties	Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDs PM0
072396

563

Duty G

564

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES

MASTER Technical Module No. WLD-G01

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **WELD RELATED REQUIREMENTS**
- **TASK:** Read Job Method Plan

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand job method plan; and,
B. Understand blueprint requirements.

INSTRUCTIONAL MATERIALS:

Student Workbook
One written test on GMAW Basic
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material V10.0-V10.04
Classroom handouts consisting of job worksheets and drawings
MASTER Handout (WLD-G1-HO)

REFERENCES:

TEXT:

Reading Welding Blueprints and Symbols, Stinchcomb, Craig, Prentice Hall, (ISBN 0-13-436-296-9), Latest Edition

OTHER:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC, Tinley Park, IL, (ISBN, 1-56637-330-1), Latest Edition
Welding: Principles and Practices, Sacks, Raymond J., Glencoe, (ISBN 0-02-666-120-9), Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN0-87263-177-X), Latest Edition

STUDENT PREPARATION:

Students should prepare by completing the Technical Mathematics modules and any course in drawing and engineering measurement tools:

INTRODUCTION:

This module assists the student in job planning, review of specifications of work, and understanding of welding terminology.

PRESENTATION OUTLINE:

Instruction Topics:

a) Identify symbols and specifications
b) Add, subtract, multiply and divide whole numbers, fractions and decimals
c) Convert Sl (metric) to US (customary) units and vice versa
d) Use calculator to perform basic arithmetic operations
e) Use standard tapes, rules and square
f) Use angle devices, such as inclinometer and protractor
g) Determine weld requirements for specific material
h) Perform measurement and inspection
i) Identify error possibilities within measurement procedures
j) Identify calibration requirements of various precision instruments
k) Alloys and selection of proper welding rod

Student Activities:

a) Review blueprints and/or drawings
b) Perform measurements with precision instruments
c) Find angles with precision instruments
d) Review the benefit of a jig or fixture to increase production and accuracy
e) Identify alloy of parent metal
f) Identify alloy for welding rod to be compatible with parent metal

PRACTICAL APPLICATION:

Students will perform preliminary job planning of an assigned welding project.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine student progress.

SUMMARY:

This module will assist the student in job methods, planning for work, and understanding specifications.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-G2) dealing with verifying and upgrading paperwork.

WLD-G1-HO
Read Job Method Plan
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand job method plan; and,
B. Understand blueprint requirements.

MODULE OUTLINE:

Instruction Topics:

a) Identify symbols and specifications
b) Add, subtract, multiply and divide whole numbers, fractions and decimals
c) Convert SI (metric) to US (customary) units and vice versa
d) Use calculator to perform basic arithmetic operations
e) Use standard tapes, rules and square
f) Use angle devices, such as inclinometer and protractor
g) Determine weld requirements for specific material
h) Perform measurement and inspection
i) Identify error possibilities within measurement procedures
j) Identify calibration requirements of various precision instruments
k) Alloys and selection of proper welding rod

Student Activities:

a) Review blueprints and/or drawings
b) Perform measurements with precision instruments
c) Find angles with precision instruments
d) Review the benefit of a jig or fixture to increase production and accuracy
e) Identify alloy of parent metal
f) Identify alloy for welding rod to be compatible with parent metal

WELDER SERIES

MASTER Technical Module No. WLD-G02

SUBJECT: WELDING TECHNICIAN TIME: HOURS

- **DUTY:** **WELD RELATED REQUIREMENTS**
- **TASK:** Verify and Upgrade Paperwork

INSTRUCTIONAL MATERIALS

Student Workbook
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material V10.0-V10.04
Classroom handouts
MASTER Handout (WLD-G2-HO)

REFERENCES:

TEXT:

Reading Welding Blueprints and Symbols, Stinchcomb, Craig, Prentice Hall, (ISBN 0-13-436-296-9), Latest Edition

OTHER:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC, Tinley Park, IL, (ISBN, 1-56637-330-1), Latest Edition
Welding: Principles and Practices, Sacks, Raymond J., Glencoe, (ISBN 0-02-666-120-9), Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN0-87263-177-X), Latest Edition

---

STUDENT PREPARATION:

Students should prepare by completing the Technical Mathematics modules and any course in drawing and engineering measurement tools.

INTRODUCTION:

This module will prepare the student in work orders, shop procedures, codes, and production planning.

PRESENTATION OUTLINE:

Instruction Topics:

a) Identify symbols and specifications
b) Work orders
c) Production planning
d) Job tickets or packets
e) Obtaining proper materials and alloys

Student Activities (in practical exercise format):

a) Review blueprints and/or drawings
b) Review codes and specifications
c) Follow job order process
d) Ordering and casting of appropriate materials
e) Complete production planning

PRACTICAL APPLICATION:

This module will teach job evaluation, sourcing and casting of materials and labor, and production layout.

EVALUATION AND/OR VERIFICATION:

Student will complete the planning and paperwork steps in class and then visit a state-of-the-art facility for questions/answers.

SUMMARY:

Students must learn the steps to job assessment, planning and casting in order to have a productive and viable operation.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-G3) dealing with interpreting drawings and blueprints.

WLD-G2-HO
Verify and Upgrade Paperwork
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Review work orders, standard procedures, codes and requirements; and,

B. Make changes to paperwork when necessary.

MODULE OUTLINE:

Instruction Topics:

a) Identify symbols and specifications

b) Work orders

c) Production planning

d) Job tickets or packets

e) Obtaining proper materials and alloys

Student Activities (in practical exercise format):

a) Review blueprints and/or drawings

b) Review codes and specifications

c) Follow job order process

d) Ordering and casting of appropriate materials

e) Complete production planning

WELDER SERIES

MASTER Technical Module No. WLD-G03

SUBJECT: WELDING TECHNICIAN **TIME:** 4 HOURS

- **DUTY:** **WELD RELATED REQUIREMENTS**
- **TASK:** Interpret Drawings and Blueprints

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Understand information given from a blueprint or drawing;
B. Understand lines, letter descriptions and abbreviations;
C. Understand types of projections; and,
D. Understand section views.

INSTRUCTIONAL MATERIALS:

Student Workbook EW-269 GMAW Basic
Transparencies will be prepared to emphasize each subject
Classroom handouts will consist of student drawings, worksheets, and alloy charts
MASTER Handout No. 1 (WL:D-G3-HO1)
MASTER Handout No. 2 (WLD-G3-HO2)
MASTER Handout No. 3 (WLD-G3-HO3)
MASTER Handout No. 4 (WLD-G3-HO4)
MASTER Handout No. 5 (WLD-G3-HO5)
MASTER Laboratory Aid (WLD-G3-LA)
MASTER Laboratory Exercise (WLD-G3-LE)
MASTER Laboratory Worksheet (WLD-G3-LW)
MASTER Self-Assessment

REFERENCES:

TEXT:

Reading Welding Blueprints and Symbols, Stinchcomb, Craig, Prentice Hall, (ISBN 0-13-436-296-9), Latest Edition

OTHER:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC, Tinley Park, IL, (ISBN, 1-56637-330-1), Latest Edition
Welding: Principles and Practices, Sacks, Raymond J., Glencoe, (ISBN 0-02-666-120-9), Latest Edition

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN0-87263-177-X), Latest Edition

---

STUDENT PREPARATION:

Students should prepare by completing the Technical Mathematics modules and any course in drawing and engineering measurement tools

---

INTRODUCTION:

This module will prepare the welder for interpretation of drawings and blueprints.

PRESENTATION OUTLINE:

Instruction Topics:

- a) Identify symbols and specifications
- b) The layouts of blueprints
- c) Lines and abbreviations
- d) Special instructions for welders

Student Activities:

- a) Review blueprints and/or drawings
- b) Prepare a drawing for an assigned welding project

PRACTICAL APPLICATION:

Drawing interpretation may determine those parts that are made or out-sourced. It also has major cost implications and can result in profit or loss.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section. The drawing will also be evaluated.

SUMMARY:

The interpretation of drawings is an important skill for welders. If properly used, it can prevent non-conforming product and rework.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-G4) dealing with reading welding specifications and procedures.

WLD-G3-HO1
Interpret Drawings and Blueprints
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand information given from a blueprint or drawing;
B. Understand lines, letter descriptions and abbreviations;
C. Understand types of projections; and,
D. Understand section views.

MODULE OUTLINE:

Instruction Topics:

a) Identify symbols and specifications
b) The layouts of blueprints
c) Lines and abbreviations
d) Special instructions for welders

Student Activities:

a) Review blueprints and/or drawings
b) Prepare a drawing for an assigned welding project

WLD-G3-HO2
Interpret Drawings and Blueprints
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Identify organizations that classify metals;
b. Distinguish between types of metal by manufacturing method and/or shape;
c. Identify designation of each digit of a metal classification;
d. Identify carbon and alloy content of a metal using classification system;
e. Identify content of an unknown metal using shop tests; and,
f. Identify conformity of a metal to a specification system.

MODULE OUTLINE:

I. Identify the Organizations That Classify Metals and Discuss the Significance of Each
    A. American Iron and Steel Institute (AISI)
    B. Society of Automotive Engineers (SAE)
    C. American Society for Testing and Materials (ASTM)
    D. American National Standards Institute (ANSI)
    E. Aluminum Association
II. Identify Classifications by Manufacturing Methods or Processes
    A. Hot rolled
    B. Cold rolled
    C. Turned and polished (sometimes referred to as ground and polished)
    D. Castings
    E. Forgings
    F. Galvanized
III. Identify Classifications by Shape
    A. Sheet and plate
    B. Bar stock
    C. Pipe and tubing
    D. Rod and wire
    E. Coil or strip
    F. Structural steel
IV. Discuss the AISI-SAE Numbering Systems for Carbon Steels
    A. Plain carbon steels (AISI-SAE 10xx and 15xx)
    B. Free-cutting steels (AISI-SAE 11xx and 12xx)
V. Discuss the AISI-SAE Classification Systems for Alloy Steels
    A. Manganese steels (AISI-SAE 13xx)
    B. Nickel steels (AISI-SAE 2xxx)
    C. Nickel-chromium steels (AISI-SAE 3xxx)
    D. Molybdenum steels (AISI-SAE 4xxx)
    E. Low chromium steels (AISI-SAE 5xxx)

  F. Other alloy steels (AISI-SAE 6 lxx, 8xxx, and 9xxx)
VI. Discuss the AISI-SAE Classification of Stainless Steels
  A. Chromium-nickel austenitic steels (SAE 30xxx or AISI 20x and 3xx)
  B. Ferritic chromium steels (SAE 5 lxxx or AISI 4xx and 50x)
  C. Martensitic chromium steels (SAE 5lxxx or AISI 4xx and 50x)
VII. Discuss the AISI Classification of Tool Steels
  A. High speed tool steels (AISI type M and T)
  B. Hot work tool steels (AISI type H)
  C. Cold work tool steels (AISI type D, A, and O)
  D. Shock resisting tool steels (AISI type S)
  E. Mold steels (AISI type P)
  F. Special purpose tool steels (AISI type L and F)
  G. Water hardening tool steels (AISI type W)
VIII. Discuss the Classification of Nonferrous Alloys
  A. Aluminum and aluminum alloys (Aluminum Association four digit system)
  B. Magnesium alloys (SAE type 5x and 5xx)
  C. Nickel and nickel alloys (by name)
  D. Titanium and titanium alloys (titanium and chief alloying element)
  E. Copper and copper alloys (by name and SAE standard number)
IX. Discuss the Classification of Castings
  A. Brass and bronze castings (SAE standard number)
  B. Aluminum casting alloys (Aluminum Association four digit system)
  C. Cast Iron (ASTM grade)
  D. Steel Castings (ASTM grade)
X. Discuss the Unified Numbering System (UNS) for Metals and Alloys
XI. Discuss the Basic Identification of an Unmarked Piece of Steel Using Shop Tests
  A. Observation
  B. Magnet test
  C. Hardness test
  D. Scratch test
  E. File test
  F. Chemical test
  G. Spark test
XII. Identify Specification Systems for Metals and Alloys
  A. American Society for Testing and Materials (ASTM)
  B. American National Standards Institute (ANSI)
  C. U.S. Department of Defense (military specifications)
  D. General Accounting Office (federal specifications)

WLD-G3-HO3
Interpret Drawings and Blueprints
Attachment 3: **MASTER** Handout No. 3

AISI-SAE STANDARD STEELS CLASSIFICATION

AISI-SAE	Type of Steel and Nominal Alloy Content
Carbon Steels	
10xx	Plain Carbon (Max 1% Mn.)
15xx	Plain Carbon (Max 1% - 1.65% Mn.)
11xx	Free Cutting, Resulfurized
12xx	Free Cutting, Resulfurized and Rephosporized
Manganese Steels	
13xx	1.75% Manganese
Nickel Steels	
23xx	3.50% Nickel
25xx	5.00% Nickel
Nickel-Chromium Steels	
31xx	1.25% Nickel; 0.65% and 0.80% Chromium
32xx	1.75% Nickel; 1.07% Chromium
33xx	3.50% Nickel; 1.50% and 1.57% Chromium
34xx	3.00% Nickel; 0.77% Chromium
Molybdenum Steels	
40xx	0.20% and 0.25% Molybdenum
44xx	0.40% and 0.52% Molybdenum
Chromium-Molybdenum Steels	
41xx	0.50% - 0.95% Chromium; 0.12% - 0.30% Molybdenum
Nickel-Molybdenum Steels	
46xx	0.85% and 1.82% Nickel; 0.20% and 0.25% Molybdenum
48xx	3.50% Nickel; 0.25% Molybdenum
Chromium Steels	
50xx	0.27% - 0.65% Chromium
51xx	0.80% - 1.05% Chromium
50xxx	0.50% Chromium; Min. 1.00% Carbon
51xxx	1.02% Chromium; Min. 1.00% Carbon
52xxx	1.45% Chromium; Min. 1.00% Carbon
Chromium-Vanadium Steels	
61xx	0.60% - 0.95% Chromium; 0.10% and 0.15% Vanadium
Tungsten-Chromium Steels	
72xx	1.75% Tungsten; 0.75% Chromium
Triple Alloy Steels	
43xx	1.82% Nickel; 0.50% and 0.80% Chromium; 0.25% Molybdenum
47xx	1.05% Nickel; 0.45% Chromium; 0.20% and 0.35% Molybdenum
8xxx	0.30% - 0.55% Nickel; 0.40% - 0.50% Chromium; 0.12% - 0.35% Molybdenum
92xx	1.40% and 2.00% Silicon; 0.00% and 0.65% Chromium; 0.65% - 0.85% Manganese
93xx	3.25% Nickel; 1.20% Chromium; 0.12% Molybdenum
94xx	0.45% Nickel; 0.40% Chromium; 0.12% Molybdenum
98xx	1.00% Nickel; 0.80% Chromium; 0.25% Molybdenum

AISI	SAE	Stainless Steel
2xx	302xx	Austentic Steels; 16% - 19% Chromium; 1% - 5.5% Nickel
3xx	303xx	Austentic Steels; 16% - 24% Chromium; 6% - 15% Nickel
4xx	514xx	Ferritic or Martensitic Steels; 10.5% - 18% Chromium
5xx	515xx	Ferritic or Martensitic Steels; 4% - 6% Chromium

WLD-G3-HO4
Interpret Drawings and Blueprints
Attachment 4: **MASTER** Handout No. 4

AISI TOOL STEELS CLASSIFICATION

CATEGORY DESIGNATION	AISI	GROUP DESIGNATION
High Speed Tool Steels	M T	Molybdenum Types Tungsten Types
Hot Work Tool Steels	H1 - H19 H20 - H39 H40 - H59	Chromium Types Tungsten Types Molybdenum Types
Cold Work Tool Steels	D A O	High Carbon, High Chromium Types Medium Alloy, Air Hardening Types Oil Hardening Types
Shock Resisting Tool Steels	S	------
Mold Steels	P	------
Special Purpose Tool Steels	L F	Low Alloy Types Carbon Tungsten Types
Water Hardening Tool Steels	W	------

UNIFIED NUMBERING SYSTEM (UNS) FOR METALS & ALLOYS

UNS SERIES	METAL
Nonferrous Metals and Alloys	
A00001 to A99999	Aluminum and Aluminum Alloys
C00001 to C99999	Copper and Copper Alloys
E00001 to E99999	Rare Earth and Rare Earth-Like Metals and Alloys
L00001 to L99999	Low Melting Metals and Alloys
M00001 to M99999	Miscellaneous Nonferrous Metals and Alloys
P00001 to P99999	Precious Metals and Alloys
R00001 to R99999	Reactive and Refractory Metals and Alloys
Z00001 to Z99999	Zinc and Zinc Alloys
Ferrous Metals and Alloys	
D00001 to D99999	Specified Mechanical Property Steels
F00001 to F99999	Cast Irons
G00001 to G99999	AISI and SAE Carbon and Alloy Steels (Except Tool Steels)
H00001 to H99999	AISI H-Steels
J00001 to J99999	Cast Steels (Except Tool Steels)
K00001 to K99999	Miscellaneous Steels and Ferrous Alloys
S00001 to S99999	Heat and Corrosion Resistant (Stainless Steels)
T00001 to T99999	Tool Steels

WLD-G3-HO5
Interpret Drawings and Blueprints
Attachment 5: **MASTER** Handout No. 5

EXAMPLE OF A SPECIFICATION

HOT ROLLED CARBON STEEL BARS							
Size	Tolerance		Out of Section	Size	Tolerance		Out of Section
	Plus	Minus			Plus	Minus	
Rounds, Squares and Round-Cornered Squares							
To 5/16	.005	.005	.008	Over 1-1/2 to 2	1/64	1/64	.023
Over 5/16 to 7/16	.006	.006	.009	Over 2 to 2-1/2	1/32	0	.023
Over 7/16 to 5/8	.007	.007	.010	Over 2-1/2 to 3-1/2	3/64	0	.035
Over 5/8 to 7/8	.008	.008	.012	Over 3-1/2 to 4-1/2	1/16	0	.046
Over 7/8 to 1	.009	.009	.013	Over 4-1/2 to 5-1/2	5/64	0	.058
Over 1 to 1-1/8	.010	.010	.015	Over 5-1/2 to 6-1/2	1/8	0	.070
Over 1/18 to 1-1/4	.011	.011	.016	Over 6-1/2 to 8-1/4	5/32	0	.085
Over 1-1/4 to 1-3/8	.012	.012	.018	Over 8-1/4 to 9-1/2	3/16	0	.100
Over 1-3/8 to 1-1/2	.014	.014	.021	Over 9-1/2 to 10	1/4	0	.120
Hexagons							
To 1/2	.007	.007	.011	Over 1-1/2 to 2	1/32	1/64	1/32
Over 1/2 to 1	.010	.120	.015	Over 2 to 2-1/2	3/64	1/64	3/64
Over 1 to 1-1/2	.021	.130	.025	Over 2-1/2 to 3-1/2	1/16	1/64	1/16
COLD FINISHED CARBON STEELS							
Size	Max. % Carbon			Size	Max. % Carbon		
	Up to .28	Over .28 to .55	Over .55		Up to .28	Over .28 to .55	Over .55
	Minus Tolerance				Minus Tolerance		
Cold Drawn Rounds				Cold Drawn Flats			
To 1-1/2	.002	.003	.005	To 3/4	.003	.004	.008
Over 1-1/2 to 2-1/2	.003	.004	.006	Over 3/4 to 1-1/2	.004	.005	.010
Over 2-1/2 to 4	.004	.005	.007	Over 1-1/2 to 3	.005	.006	.012
Over 4 to 6	.005	.006	.008	Over 3 to 4	.006	.008	.016
				Over 4 to 6	.008	.010	.020
				Over 6	.013	.015	——
Cold Drawn Hexagons				Cold Drawn Squares			
To 3/4	.002	.003	.006	To 3/4	.002	.004	.007
Over 3/4 to 1-1/2	.003	.004	.007	Over 3/4 to 1-1/2	.003	.005	.008
Over 1-1/2 to 2-1/2	.004	.005	.008	Over 1-1/2 to 2-1/2	.004	.006	.009
Over 2-1/2 to 3-1/8	.005	.006	.009	Over 2-1/2 to 4	.005	.008	.011
Turned and Polished Rounds							
To 1-1/2	.002	.003	.005	Over 4 to 6	.005	.006	.008
Over 1-1/2 to 2-1/2	.003	.004	.006	Over 6 to 8	.006	.007	.009
Over 2-1/2 to 4	.004	.005	.007	Over 8 to 9	.007	.008	.010

List of Materials for Shop Tests and Illustration

1. **Observation Test**
   Sample of round bars with various surface finishes (cold finished, hot rolled, ground and polished)

2. **Magnet Test**
   Sample of carbon steel, ferritic or martensitic stainless steel, austenitic stainless steel, aluminum, and nickel steel

3. **Hardness Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

4. **Scratch Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

5. **File Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

6. **Chemical Test**
   Sample of carbon steel, type 302 or 304 stainless steel, type 316 or 317 stainless steel

7. **Spark Test**
   Sample of low carbon steel, high carbon steel, cast iron, high speed steel, tool steel, and manganese steel

8. **Observation Test**
   Samples of bar stock (round and square), hot rolled sheet, cold finished coil strip, galvanized sheet, small diameter pipe, small diameter tubing, small gauge wire, hot rolled rod, and cold finished rod

WLD-G3-LE
Interpret Drawings and Blueprints
Attachment 7: **MASTER** Laboratory Exercise

---

1. The instructor will:
    a. Demonstrate use of drafting machine;
    b. Demonstrate use of drafting instruments;
    c. Demonstrate drafting techniques to create basic geometric elements;
    d. Demonstrate sketching techniques, including:
        (1) Isometric sketching;
        (2) Oblique sketching; and,
        (3) One-point and two-point perspective sketching.

2. The student will:
    a. Demonstrate use of drafting machine;
    b. Demonstrate use of drafting instruments;
    c. Demonstrate drafting techniques to create basic geometric elements, which include:
        (1) Bisecting a line or a circular arc;
        (2) Bisecting an angle and to transfer an angle;
        (3) Constructing a line parallel to a given line at a given distance;
        (4) Dividing a line into equal or proportional parts;
        (5) Constructing a triangle with the length of the sides given;
        (6) Inscribing a circle in a triangle;
        (7) Constructing a right triangle with hypotenuse and one side given;
        (8) Constructing a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line;
        (9) Constructing a square with a side given;
        (10) Inscribing a regular pentagon in a given circle;
        (11) Inscribing and circumscribing a hexagon on a given circle;
        (12) Inscribing an octagon in a given square;
        (13) Constructing a circle through three given points not in a straight line;
        (14) Constructing a circle of a given size tangent to a given line and passing through a given point;
        (15) Constructing a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line;
        (16) Constructing a circle of a given size tangent to a given circle and passing through a given point;
        (17) Constructing an arc of a given size tangent to two given intersecting lines at acute or obtuse angles;
        (18) Constructing a given size circle tangent to two given circles;
        (19) Constructing an ellipse using the concentric circle method with major and minor diameters given;

- (20) Construct an approximate ellipse with major and minor diameters given;
- d. Demonstrate sketching techniques, including:
  - (1) Isometric sketching;
  - (2) Oblique sketching; and,
  - (3) One-point and two-point perspective sketching.

3. The instructor will grade the student's performance on the student's ability to:
   - a. Demonstrate use of drafting machine;
   - b. Demonstrate use of drafting instruments;
   - c. Demonstrate drafting techniques to create basic geometric elements, which include:
     - (1) Bisecting a line or a circular arc;
     - (2) Bisecting an angle and to transfer an angle;
     - (3) Constructing a line parallel to a given line at a given distance;
     - (4) Dividing a line into equal or proportional parts;
     - (5) Constructing a triangle with the length of the sides given;
     - (6) Inscribing a circle in a triangle;
     - (7) Constructing a right triangle with hypotenuse and one side given;
     - (8) Constructing a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line;
     - (9) Constructing a square with a side given;
     - (10) Inscribing a regular pentagon in a given circle;
     - (11) Inscribing and circumscribing a hexagon on a given circle;
     - (12) Inscribing an octagon in a given square;
     - (13) Constructing a circle through three given points not in a straight line;
     - (14) Constructing a circle of a given size tangent to a given line and passing through a given point;
     - (15) Constructing a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line;
     - (16) Constructing a circle of a given size tangent to a given circle and passing through a given point;
     - (17) Constructing an arc of a given size tangent to two given intersecting lines at acute or obtuse angles;
     - (18) Constructing a given size circle tangent to two given circles;
     - (19) Constructing an ellipse using the concentric circle method with major and minor diameters given;
     - (20) Construct an approximate ellipse with major and minor diameters given.
   - d. Demonstrate sketching techniques, including:
     - (1) Isometric sketching;
     - (2) Oblique sketching; and,
     - (3) One-point and two-point perspective sketching.

WLD-G3-LW
Interpret Drawings and Blueprints
Attachment 8: **MASTER** Laboratory Worksheet

I. Identify the following:

a. AISI ________________________

b. SAE ________________________

c. ASTM ________________________

d. ANSI ________________________

e. UNS ________________________

II. Complete the following charts:

A. Standard Steels and Alloy Steels

	AISI-SAE	APP % CARBON	MAJOR ALLOYING ELEMENTS
Ex.	1020	.20	Only Carbon
Ex.	6118	.18	Chromium & Vanadium
Ex.	4340	.40	Nickel, Chromium, Molybdenum
1.	1040		
2.	1095		
3.	1212		
4.	1340		
5.	2340		
6.	2512		
7.	3140		
8.	3310		
9.	4024		
10.	4140		
11.	4320		
12.	4620		
13.	5135		
14.	52100		
15.	6150		

B. AISI-SAE-UNS Classification System

	AISI-SAE	UNS	TYPE METAL OR STEEL
Ex.	1212	G12120	Free Cutting Carbon Steel
Ex.	48xx	G48xx0	Nickel-Molybdenum Steel
Ex.	A6	T30106	Air Harden Cold Work Tool Steel
1.	1527		
2.	1151		
3.		G10290	
4.		G41xx0	
5.		G61500	
6.			Tungsten-Chromium Steels
7.			Austenitic Stainless Steels
8.			Nickel Steels
9.	H21	T20821	
10.		T12002	Tungsten High Speed Tool Steels
11.	Sx	T4190x	
12.	D2	T30402	
13.		T41906	Shock Resisting Tool Steels
14.	-----	Axxxxx	
15.			Copper and Copper Alloy

III. Answer the following questions.

A. What is the out-of-round tolerance for 2-1/2" diameter hot rolled bar?

B. What is the size tolerance for 1-3/4" cold finished hexagon bar made from 1045?

C. If the only requirements given you were 1" 1018 square bar with a size tolerance of -.006, would you choose hot rolled (much cheaper) or cold finished stock?

IV. Record the results of your shop test below.

Item No.	Test Used	Kind of Metal
1.		
2.		
3.		
4.		
5.		

Name: ______________________________ Date: ____________________

WLD-G3
Interpret Drawings and Blueprints
Self-Assessment

1. Who is the AISI?

____
____
____

2. Who is the SAE?

____
____
____

3. What organization's classification system of aluminum and aluminum alloys is accepted by industry and used by commercial producers?

____
____
____

4. What organization has published a specification system for metals and alloys?

____
____
____

5. Name three classes of metals by manufacturing method, process, or material finish.

____
____
____

6. Identify four basic shapes that metals are produced in.

____
____
____

7. What do the first two digits of a steel name designate?

____
____
____

8. What do the last two digits (in a four-digit name) designate?

9. What is the approximate percent of carbon in 1045 carbon steel?

10. What is the approximate percent of carbon in 52100 chromium steel?

11. What type steel is 4147?

12. What is the alloying element in 2517 steel? What percent of that element is present?

13. If the element chromium makes steel stainless, why are the 5xxx and 5xxxx steels not included in the stainless steel group?

14. Name three types of stainless steel.

15. Which types are magnetic?

16. What element is added to austenitic stainless steels to improve ductility and other properties?

17. What type steel is indicated by the symbol Wl or A6?

18. What type tool steel is designated by the symbol D (category and group designations)?

19. What three groups of cold work tool steels are available?

20. What is the designation for water hardening tool steel?

21. Identify three categories of nonferrous alloys.

22. What category of nonferrous metals does brass and bronze belong to?

23. What does the first digit of an aluminum designation identify?

24. What are the basic temper designations and subdivisions for aluminum alloys?

25. Name 5 basic types of cast iron.

26. Name 2 basic types of steel castings.

27. What is the UNS designation for 1212 free cutting carbon steel?

28. What type metal are the T series numbers reserved for in the UNS numbering system?

29. What does a G as the first digit of a UNS classification designate?

30. What is the AISI-SAE classification for a G13300 steel?

31. When checking the hardness of a piece of steel with the file test, the file slides over the surface without cutting. What type steel is it most likely to be?

32. What can you determine about a metal by observation?

33. If an unknown sample can not be scratched by a piece of mild steel keystock but the keystock can be scratched by the sample, what conclusion can you draw about the sample?

____

____

____

34. If a hardness tester is not available, how can you determine relative hardness of a sample?

____

____

____

35. When spark testing a sample to determine carbon content, what does orange carrier lines ending in pear-shaped globules and very little branching indicate?

____

____

____

36. What is the out-of-round tolerance for 2-1/2" diameter hot rolled bar?

____

____

____

37. What is the maximum width of 1-1/4" key made from 1045 cold finished square bar? What is the minimum width?

____

____

____

38. What is the maximum diameter of a shaft made from 5" hot rolled 1018 bar? What is the minimum?

____

____

____

39. Name two other specification systems in use.

____

____

____

40. Define color coding and explain what it is used for.

____

____

____

WELDER SERIES

MASTER Technical Module No. WLD-G04

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **WELD RELATED REQUIREMENTS**
- **TASK:** Read Welding Specifications and Procedures

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Understand specifications and procedures; and,
B. Understand tolerances, defects, and discontinuities.

INSTRUCTIONAL MATERIALS:

Student Workbook
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material V10.0-V10.04
Classroom handouts
MASTER Handout No. 1 (WLD-G4-HO1)
MASTER Handout No. 2 (WLD-G4-HO2)
MASTER Handout No. 3 (WLD-G4-HO3)
MASTER Handout No. 4 (WLD-G4-HO4)
MASTER Handout No. 5 (WLD-G4-HO5)
MASTER Handout No. 6 (WLD-G4-HO6)
MASTER Handout No. 7 (WLD-G4-HO7)
MASTER Handout No. 8 (WLD-G4-HO8)
MASTER Handout No. 9 (WLD-G4-HO9)
MASTER Laboratory Aid (WLD-G4-LA)
MASTER Laboratory Worksheet (WLD-G4-LW)
MASTER Self-Assessment

REFERENCES:

TEXT:

Reading Welding Blueprints and Symbols, Stinchcomb, Craig, Prentice Hall, (ISBN 0-13-436-296-9), Latest Edition

OTHER:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC, Tinley Park, IL, (ISBN, 1-56637-330-1), Latest Edition
Welding: Principles and Practices, Sacks, Raymond J., Glencoe, (ISBN 0-02-666-120-9), Latest Edition

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN0-87263-177-X), Latest Edition

---

STUDENT PREPARATION:

Students should prepare by completing the Technical Mathematics modules and any course in drawing and engineering measurement tools

---

INTRODUCTION:

Welding specifications and procedures require much training and preparation. Students need the requisite welding practice and knowledge of reference materials that range from AWS symbols, metallurgy, procedures for many types of welding, and standards on desired welding outcomes.

PRESENTATION OUTLINE:

Instruction Topics:

a) Identify symbols and specifications
b) Accepted procedures for types of welding operations (sources)
c) Dimensioning tolerancing
d) Weld defects and discontinuities
e) Weld quality standards

Student Activities:

a) Review blueprints and/or drawings
b) See examples of weld defects and discontinuities

PRACTICAL APPLICATION:

Students will review the many types of weld defects and discontinuities.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

Welding specifications require exact procedures to be followed by the welder who must also be skilled in the inspection of his own work.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H1) dealing with understanding parts of blueprint.

WLD-G4-HO1
Read Welding Specifications and Procedures
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand specifications and procedures; and,

B. Understand tolerances, defects, and discontinuities.

MODULE OUTLINE:

Instruction Topics:

a) Identify symbols and specifications

b) Accepted procedures for types of welding operations (sources)

c) Dimensioning tolerancing

d) Weld defects and discontinuities

e) Weld quality standards

Student Activities:

a) View blueprints and/or drawings

b) See examples of weld defects and discontinuities

WLD-G4-HO2
Read Welding Specifications and Procedures
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Identify organizations that classify metals;
b. Distinguish between types of metal by manufacturing method and/or shape;
c. Identify designation of each digit of a metal classification;
d. Identify carbon and alloy content of a metal using classification system;
e. Identify content of an unknown metal using shop tests; and,
f. Identify conformity of a metal to a specification system.

MODULE OUTLINE:

I. Identify the Organizations That Classify Metals and Discuss the Significance of Each
  A. American Iron and Steel Institute (AISI)
  B. Society of Automotive Engineers (SAE)
  C. American Society for Testing and Materials (ASTM)
  D. American National Standards Institute (ANSI)
  E. Aluminum Association
II. Identify Classifications by Manufacturing Methods or Processes
  A. Hot rolled
  B. Cold rolled
  C. Turned and polished (sometimes referred to as ground and polished)
  D. Castings
  E. Forgings
  F. Galvanized
III. Identify Classifications by Shape
  A. Sheet and plate
  B. Bar stock
  C. Pipe and tubing
  D. Rod and wire
  E. Coil or strip
  F. Structural steel
IV. Discuss the AISI-SAE Numbering Systems for Carbon Steels
  A. Plain carbon steels (AISI-SAE 10xx and 15xx)
  B. Free-cutting steels (AISI-SAE 11xx and 12xx)
V. Discuss the AISI-SAE Classification Systems for Alloy Steels
  A. Manganese steels (AISI-SAE 13xx)
  B. Nickel steels (AISI-SAE 2xxx)
  C. Nickel-chromium steels (AISI-SAE 3xxx)
  D. Molybdenum steels (AISI-SAE 4xxx)
  E. Low chromium steels (AISI-SAE 5xxx)
  F. Other alloy steels (AISI-SAE 6 lxx, 8xxx, and 9xxx)
VI. Discuss the AISI-SAE Classification of Stainless Steels

A. Chromium-nickel austenitic steels (SAE 30xxx or AISI 20x and 3xx)
B. Ferritic chromium steels (SAE 5 lxxx or AISI 4xx and 50x)
C. Martensitic chromium steels (SAE 5lxxx or AISI 4xx and 50x)

VII. Discuss the AISI Classification of Tool Steels
A. High speed tool steels (AISI type M and T)
B. Hot work tool steels (AISI type H)
C. Cold work tool steels (AISI type D, A, and O)
D. Shock resisting tool steels (AISI type S)
E. Mold steels (AISI type P)
F. Special purpose tool steels (AISI type L and F)
G. Water hardening tool steels (AISI type W)

VIII. Discuss the Classification of Nonferrous Alloys
A. Aluminum and aluminum alloys (Aluminum Association four digit system)
B. Magnesium alloys (SAE type 5x and 5xx)
C. Nickel and nickel alloys (by name)
D. Titanium and titanium alloys (titanium and chief alloying element)
E. Copper and copper alloys (by name and SAE standard number)

IX. Discuss the Classification of Castings
A. Brass and bronze castings (SAE standard number)
B. Aluminum casting alloys (Aluminum Association four digit system)
C. Cast Iron (ASTM grade)
D. Steel Castings (ASTM grade)

X. Discuss the Unified Numbering System (UNS) for Metals and Alloys

XI. Discuss the Basic Identification of an Unmarked Piece of Steel Using Shop Tests
A. Observation
B. Magnet test
C. Hardness test
D. Scratch test
E. File test
F. Chemical test
G. Spark test

XII. Identify Specification Systems for Metals and Alloys
A. American Society for Testing and Materials (ASTM)
B. American National Standards Institute (ANSI)
C. U.S. Department of Defense (military specifications)
D. General Accounting Office (federal specifications)

WLD-G4-HO3
Read Welding Specifications and Procedures
Attachment 3: **MASTER** Handout No. 3

AISI-SAE STANDARD STEELS CLASSIFICATION

AISI-SAE	Type of Steel and Nominal Alloy Content
Carbon Steels	
10xx	Plain Carbon (Max 1% Mn.)
15xx	Plain Carbon (Max 1% - 1.65% Mn.)
11xx	Free Cutting, Resulfurized
12xx	Free Cutting, Resulfurized and Rephosporized
Manganese Steels	
13xx	1.75% Manganese
Nickel Steels	
23xx	3.50% Nickel
25xx	5.00% Nickel
Nickel-Chromium Steels	
31xx	1.25% Nickel; 0.65% and 0.80% Chromium
32xx	1.75% Nickel; 1.07% Chromium
33xx	3.50% Nickel; 1.50% and 1.57% Chromium
34xx	3.00% Nickel; 0.77% Chromium
Molybdenum Steels	
40xx	0.20% and 0.25% Molybdenum
44xx	0.40% and 0.52% Molybdenum
Chromium-Molybdenum Steels	
41xx	0.50% - 0.95% Chromium; 0.12% - 0.30% Molybdenum
Nickel-Molybdenum Steels	
46xx	0.85% and 1.82% Nickel; 0.20% and 0.25% Molybdenum
48xx	3.50% Nickel; 0.25% Molybdenum
Chromium Steels	
50xx	0.27% - 0.65% Chromium
51xx	0.80% - 1.05% Chromium
50xxx	0.50% Chromium; Min. 1.00% Carbon
51xxx	1.02% Chromium; Min. 1.00% Carbon
52xxx	1.45% Chromium; Min. 1.00% Carbon
Chromium-Vanadium Steels	
61xx	0.60% - 0.95% Chromium; 0.10% and 0.15% Vanadium
Tungsten-Chromium Steels	
72xx	1.75% Tungsten; 0.75% Chromium
Triple Alloy Steels	
43xx	1.82% Nickel; 0.50% and 0.80% Chromium; 0.25% Molybdenum
47xx	1.05% Nickel; 0.45% Chromium; 0.20% and 0.35% Molybdenum
8xxx	0.30% - 0.55% Nickel; 0.40% - 0.50% Chromium; 0.12% - 0.35% Molybdenum
92xx	1.40% and 2.00% Silicon; 0.00% and 0.65% Chromium; 0.65% - 0.85% Manganese
93xx	3.25% Nickel; 1.20% Chromium; 0.12% Molybdenum
94xx	0.45% Nickel; 0.40% Chromium; 0.12% Molybdenum
98xx	1.00% Nickel; 0.80% Chromium; 0.25% Molybdenum

AISI	SAE	Stainless Steel
2xx	302xx	Austentic Steels; 16% - 19% Chromium; 1% - 5.5% Nickel
3xx	303xx	Austentic Steels; 16% - 24% Chromium; 6% - 15% Nickel
4xx	514xx	Ferritic or Martensitic Steels; 10.5% - 18% Chromium
5xx	515xx	Ferritic or Martensitic Steels; 4% - 6% Chromium

WLD-G4-HO4
Read Welding Specifications and Procedures
Attachment 4: **MASTER** Handout No. 4

AISI TOOL STEELS CLASSIFICATION

CATEGORY DESIGNATION	AISI	GROUP DESIGNATION
High Speed Tool Steels	M T	Molybdenum Types Tungsten Types
Hot Work Tool Steels	H1 - H19 H20 - H39 H40 - H59	Chromium Types Tungsten Types Molybdenum Types
Cold Work Tool Steels	D A O	High Carbon, High Chromium Types Medium Alloy, Air Hardening Types Oil Hardening Types
Shock Resisting Tool Steels	S	------
Mold Steels	P	------
Special Purpose Tool Steels	L F	Low Alloy Types Carbon Tungsten Types
Water Hardening Tool Steels	W	------

UNIFIED NUMBERING SYSTEM (UNS) FOR METALS & ALLOYS

UNS SERIES	METAL
Nonferrous Metals and Alloys	
A00001 to A99999	Aluminum and Aluminum Alloys
C00001 to C99999	Copper and Copper Alloys
E00001 to E99999	Rare Earth and Rare Earth-Like Metals and Alloys
L00001 to L99999	Low Melting Metals and Alloys
M00001 to M99999	Miscellaneous Nonferrous Metals and Alloys
P00001 to P99999	Precious Metals and Alloys
R00001 to R99999	Reactive and Refractory Metals and Alloys
Z00001 to Z99999	Zinc and Zinc Alloys
Ferrous Metals and Alloys	
D00001 to D99999	Specified Mechanical Property Steels
F00001 to F99999	Cast Irons
G00001 to G99999	AISI and SAE Carbon and Alloy Steels (Except Tool Steels)
H00001 to H99999	AISI H-Steels
J00001 to J99999	Cast Steels (Except Tool Steels)
K00001 to K99999	Miscellaneous Steels and Ferrous Alloys
S00001 to S99999	Heat and Corrosion Resistant (Stainless Steels)
T00001 to T99999	Tool Steels

WLD-G4-HO5

Read Welding Specifications and Procedures

Attachment 5: **MASTER** Handout No. 5

EXAMPLE OF A SPECIFICATION

HOT ROLLED CARBON STEEL BARS							
	Tolerance		Out of		Tolerance		Out of
Size	Plus	Minus	Section	Size	Plus	Minus	Section
Rounds, Squares and Round-Cornered Squares							
To 5/16	.005	.005	.008	Over 1-1/2 to 2	1/64	1/64	.023
Over 5/16 to 7/16	.006	.006	.009	Over 2 to 2-1/2	1/32	0	.023
Over 7/16 to 5/8	.007	.007	.010	Over 2-1/2 to 3-1/2	3/64	0	.035
Over 5/8 to 7/8	.008	.008	.012	Over 3-1/2 to 4-1/2	1/16	0	.046
Over 7/8 to 1	.009	.009	.013	Over 4-1/2 to 5-1/2	5/64	0	.058
Over 1 to 1-1/8	.010	.010	.015	Over 5-1/2 to 6-1/2	1/8	0	.070
Over 1/18 to 1-1/4	.011	.011	.016	Over 6-1/2 to 8-1/4	5/32	0	.085
Over 1-1/4 to 1-3/8	.012	.012	.018	Over 8-1/4 to 9-1/2	3/16	0	.100
Over 1-3/8 to 1-1/2	.014	.014	.021	Over 9-1/2 to 10	¼	0	.120
Hexagons							
To 1/2	.007	.007	.011	Over 1-1/2 to 2	1/32	1/64	1/32
Over 1/2 to 1	.010	.120	.015	Over 2 to 2-1/2	3/64	1/64	3/64
Over 1 to 1-1/2	.021	.130	.025	Over 2-1/2 to 3-1/2	1/16	1/64	1/16
COLD FINISHED CARBON STEELS							
	Max. % Carbon				Max. % Carbon		
Size	Up to .28	Over .28 to .55	Over .55	Size	Up to .28	Over .28 to .55	Over .55
	Minus Tolerance				Minus Tolerance		
Cold Drawn Rounds				Cold Drawn Flats			
To 1-1/2	.002	.003	.005	To 3/4	.003	.004	.008
Over 1-1/2 to 2-1/2	.003	.004	.006	Over 3/4 to 1-1/2	.004	.005	.010
Over 2-1/2 to 4	.004	.005	.007	Over 1-1/2 to 3	.005	.006	.012
Over 4 to 6	.005	.006	.008	Over 3 to 4	.006	.008	.016
				Over 4 to 6	.008	.010	.020
				Over 6	.013	.015	——
Cold Drawn Hexagons				Cold Drawn Squares			
To 3/4	.002	.003	.006	To 3/4	.002	.004	.007
Over 3/4 to 1-1/2	.003	.004	.007	Over 3/4 to 1-1/2	.003	.005	.008
Over 1-1/2 to 2-1/2	.004	.005	.008	Over 1-1/2 to 2-1/2	.004	.006	.009
Over 2-1/2 to 3-1/8	.005	.006	.009	Over 2-1/2 to 4	.005	.008	.011
Turned and Polished Rounds							
To 1-1/2	.002	.003	.005	Over 4 to 6	.005	.006	.008
Over 1-1/2 to 2-1/2	.003	.004	.006	Over 6 to 8	.006	.007	.009
Over 2-1/2 to 4	.004	.005	.007	Over 8 to 9	.007	.008	.010

WLD-G4-HO6
Read Welding Specifications and Procedures
Attachment 6: **MASTER** Handout No. 6

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss classification system for metals; and,
b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals.

MODULE OUTLINE:

I. Discuss the Physical Properties of Metal
  A. Brittleness - the property of a metal which permits no permanent distortion before breaking
  B. Ductility - the ability of the metal to be permanently deformed without breaking
  C. Elasticity - the ability of a metal to return to its original shape after any force acting upon it has been removed
  D. Hardness - the resistance to forcible penetration
  E. Malleability - the property of a metal which permits it to be hammered or rolled into other sizes and shapes
  F. Tensile strength - the maximum amount of pull that a material will withstand before breaking
  G. Toughness - the property of a metal to withstand shock or impact
II. Discuss the Classification System for Steel
  A. Carbon steels
    1. Low carbon steel - contains from 0.02 to 0.20 percent of carbon
    2. Medium carbon steel - contains from 0.30 to 0.60 percent of carbon
    3. High carbon steel (tool steel) - contains over 0.60 percent of carbon
  B. Alloy steels - alloying elements allow steels to possess special characteristics
  Discuss Table 1.1 "Effects of Alloying Elements on Steel"
  Discuss Table 1.2 "SAE-ANSI Numerical Designation of Alloy Steels"
III. Describe General Characteristics For:
  A. Carbon Steels
  B. Tool Steels
  C. Stainless Steels
  D. Structural Steels
  E. Cast Irons
  F. Non-Ferrous Metals
    1. Aluminum and Its Alloys
    2. Copper and Its Alloys
    3. Nickel Alloys
    4. Precious Metals
    5. Others

WLD-G4-HO7
Read Welding Specifications and Procedures
Attachment 7: **MASTER** Handout No. 7

TABLES FOR PROPERTIES OF METALS
TABLE 1.1

THE EFFECT OF ALLOYING ELEMENTS ON STEEL

Effect	Elements											
	carbon	chromium	cobalt	lead	manganese	Molybdenum	nickel	phosphorus	silicon	sulfur	tungsten	vanadium
Increases tensile strength	x	x			x	x	x					
Increases hardness	x	x										
Increases wear resistance	x	x			x		x				x	
Increases hardenability	x	x			x	x	x					x
Increases ductility					x							
Increases elastic limit		x				x						
Increases rust resistance		x					x					
Increases abrasion resistance		x			x							
Increases toughness		x				x	x					x
Increases shock resistance		x					x					x
Increases fatigue resistance												x
Decreases ductility	x	x										
Decreases toughness			x									
Raises critical temperature		x	x								x	
Lowers critical temperature					x		x					
Causes hot shortness										x		
Causes cold shortness								X				
Imparts red hardness			x			x					x	
Imparts fine grain structure					x							x
Reduces deformation					x		x					
Acts as deoxidizer					x				x			
Acts as desulphurizer					x							
Imparts oil hardening properties		x			x	x	x					
Imparts air hardening properties					x	x						
Eliminates blow holes								X				
Creates soundness in casting									x			
Facilitates rolling and forging					x				x			
Improves machinability				x						x		

WLD-G4-HO8
Read Welding Specifications and Procedures
Attachment 8: **MASTER** Handout No. 8

TABLE 1.2

SAE-AISI NUMERICAL DESIGNATION OF ALLOY STEELS
(x represents percent of carbon in hundredths)

Carbon Steels	
Plain carbon	10xx
Free-cutting, resulfurized	11xx
Manganese Steels	13xx
Nickel Steels	
.50% nickel	20xx
1.50% nickel	21xx
3.50% nickel	23xx
5.00% nickel	25xx
Nickel-Chromium Steels	
1.25% nickel, .65% chromium	31xx
1.75% nickel, 1.00% chromium	32xx
3.50% nickel, 1.57% chromium	33xx
3.00% nickel, .80% chromium	34xx
Corrosion and heat-resisting steels	303xx
Molybdenum Steels	
Chromium	41xx
Chromium-nickel	43xx
Nickel	46xx and 48xx
Chromium Steels	
Low-chromium	50xx
Medium-chromium	511xx
High-chromium	521xx
Chromium-Vanadium Steels	6xxx
Tungsten Steels	7xxx and 7xxxx
Triple-Alloy Steels	8xxx
Silicon-Manganese Steels	9xxx
Leaded Steels	11Lxx (example)

WLD-G4-HO9
Read Welding Specifications and Procedures
Attachment 9: **MASTER** Handout No. 9

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Briefly describe and list the advantages and disadvantages for each of the following: casting processes, hot working processes, and cold working processes;
b. Discuss service requirements (strength, hardness, etc.);
c. Discuss fastening processes (fasteners, welding, bonding, etc.); and,
d. Discuss corrosion resistance methods.

MODULE OUTLINE:

I. Describe Casting Processes
  A. Discuss the following casting processes: sand, evaporative, shell molding, permanent mold, centrifugal, investment, and die casting
  B. Discuss pattern and mold design factors for each of the above casting processes
  C. List the advantages and disadvantages of the casting processes
II. Describe Hot Working Processes
  A. Discuss the following hot working processes: rolling, strand casting, forging, drawing, extrusion, spinning, and roll forming
  B. List the advantages and disadvantages of the hot working processes
III. Describe Cold Working Processes
  A. Discuss the following cold working processes: rolling, blanking, pressing, drawing, extruding, wire and bar drawing, bending, shearing, and roll forming
  B. List the advantages and disadvantages of the cold working process
IV. Evaluate Alternative Manufacturing Processes
  A. Discuss the powder metallurgy process (PM)
  B. Discuss the following nontraditional machining processes: EDM, laser machining, ultrasonic machining, hydrojet machining, electron beam machining, and plasma beam machining

---

List of Materials for Shop Tests and Illustration

1. **Observation Test**
   Sample of round bars with various surface finishes (cold finished, hot rolled, ground and polished)

2. **Magnet Test**
   Sample of carbon steel, ferritic or martensitic stainless steel, austenitic stainless steel, aluminum, and nickel steel

3. **Hardness Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

4. **Scratch Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

5. **File Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

6. **Chemical Test**
   Sample of carbon steel, type 302 or 304 stainless steel, type 316 or 317 stainless steel

7. **Spark Test**
   Sample of low carbon steel, high carbon steel, cast iron, high speed steel, tool steel, and manganese steel

8. **Observation Test**
   Samples of bar stock (round and square), hot rolled sheet, cold finished coil strip, galvanized sheet, small diameter pipe, small diameter tubing, small gauge wire, hot rolled rod, and cold finished rod

WLD-G4-LW

Read Welding Specifications and Procedures

Attachment 11: **MASTER** Laboratory Worksheet

I. Identify the following:

a. AISI ____________________________________

b. SAE ____________________________________

c. ASTM ____________________________________

d. ANSI ____________________________________

e. UNS ____________________________________

II. Complete the following charts:

A. Standard Steels and Alloy Steels

	AISI-SAE	APP % CARBON	MAJOR ALLOYING ELEMENTS
Ex.	1020	.20	Only Carbon
Ex.	6118	.18	Chromium & Vanadium
Ex.	4340	.40	Nickel, Chromium, Molybdenum
1.	1040		
2.	1095		
3.	1212		
4.	1340		
5.	2340		
6.	2512		
7.	3140		
8.	3310		
9.	4024		
10.	4140		
11.	4320		
12.	4620		
13.	5135		
14.	52100		
15.	6150		

B. AISI-SAE-UNS Classification System

	AISI-SAE	UNS	TYPE METAL OR STEEL
Ex.	1212	G12120	Free Cutting Carbon Steel
Ex.	48xx	G48xx0	Nickel-Molybdenum Steel
Ex.	A6	T30106	Air Harden Cold Work Tool Steel
1.	1527		
2.	1151		
3.		G10290	
4.		G41xx0	
5.		G61500	
6.			Tungsten-Chromium Steels
7.			Austenitic Stainless Steels
8.			Nickel Steels
9.	H21	T20821	
10.		T12002	Tungsten High Speed Tool Steels
11.	Sx	T4190x	
12.	D2	T30402	
13.		T41906	Shock Resisting Tool Steels
14.	-----	Axxxxx	
15.			Copper and Copper Alloy

III. Answer the following questions:

A. What is the out-of-round tolerance for 2-1/2" diameter hot rolled bar?

____

____

B. What is the size tolerance for 1-3/4" cold finished hexagon bar made from 1045?

____

____

C. If the only requirements given you were 1" 1018 square bar with a size tolerance of -.006, would you choose hot rolled (much cheaper) or cold finished stock?

____

____

IV. Record the results of your shop test below.

Item No.	Test Used	Kind of Metal
1.		
2.		
3.		
4.		
5.		

Name: ______________________________ Date: ____________________

WLD-G4
Read Welding Specifications and Procedures
Self-Assessment

Circle the best answer.

1. Using the SAE system, 1008 indicates
   a. plain carbon steel, 8% carbon
   b. plain carbon steel, 0.8% carbon
   c. plain carbon steel, 0.08% carbon
   d. low chromium steel, 0.08% carbon
   e. none of the above

2. In the SAE system, triple-alloy steels are designated by the numeral _____
   a. 6
   b. 7
   c. 8
   d. 9
   e. none of the above

3. The AISI system uses __________ to indicate the process used to manufacture the steel.
   a. numerical prefixes
   b. numerical suffixes
   c. capital letter prefixes
   d. capital letter suffixes
   e. none of the above

4. Which of the following does NOT increase the tensile strength of steel?
   a. carbon
   b. molybdenum
   c. nickel
   d. all of the above
   e. none of the above

5. Which of the following elements decreases the *toughness* of steel?
   a. cobalt
   b. phosphorus
   c. vanadium
   d. all of the above
   e. none of the above

6. Which of the following elements imparts *fine grain structure* to steel?
   a. chromium
   b. manganese
   c. silicon
   d. tungsten
   e. none of the above

7. The AISI prefix B designates that the steel is
   a. acid bessemer carbon steel
   b. basic open hearth carbon steel
   c. acid open hearth carbon steel
   d. brass
   e. none of the above

8. __________ Steels have their own alphabetic classification system.
   a. stainless
   b. low carbon
   c. tool
   d. austenitic
   e. none of the above

9. __________ stainless steel can not be hardened by quenching.
   a. austenitic
   b. ferritic
   c. martensitic
   d. all of the above
   e. none of the above

10. Which of the following metals is magnetic?
   a. phosphorus
   b. silicon
   c. sulfur
   d. all of the above
   e. none of the above

WLD-G4
Read Welding Specifications and Procedures
Self-Assessment Answer Key

1. c

2. c

3. c

4. d

5. a

6. b

7. a

8. c

9. a

10. e

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW [illegible] and [illegible] T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

Duty H

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES

MASTER Technical Module No. WLD-H01

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Understand Parts of Blueprint

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Introduce related terms and definitions;
B. Define proper terms and definitions;
C. Define lines, dimensions and notes;
D. Perform metric conversions;
E. Discuss orthographic views;
F. Interpret blueprint information; and,
G. Depict proper layout.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Classroom handouts
MASTER Handout No. 1 (WLD-H1-HO1)
MASTER Handout No. 2 (WLD-H1-HO2)
MASTER Handout No. 3 (WLD-H1-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition

Blueprint Reading for Welders, Bennett, A. E. and Siy, L. J., Delmar Publishers, Latest Edition
Welding Blueprints & Symbols, Stinchcomb, Craig, Prentice Hall, (ISBN 0-13-436296-9), Latest Edition

---

STUDENT PREPARATION:

The purpose of this program is to assist the student in the use of facilities and equipment to improve skill levels. Blueprinting of structural layout and fit-up are important areas of knowledge and skills for the welder.

INTRODUCTION:

The Module Introduction will Include:

- The importance of blueprints and drawings to successful welding outcomes; and,
- A class demonstration of effective drawing and interpretation techniques.

PRESENTATION OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup
B. Demonstrate how to use the reference on a blueprint
C. Lines, dimensions and notes
D. Demonstrate how to scribe a line using a square and a protractor
E. Illustrate how to use the print to find angles
F. Define the following: precision, reliability and accuracy
G. Define tolerance and how to find it on a blueprint
H. Metrics for welders
I. Demonstrate semi-precision measurements techniques
J. Discuss the importance of the tolerance
K. Discriminate between accepted measurement procedures and improper measurement procedures
L. Explain calibration requirements of various precision instruments
M. Illustrate where to locate measurements

Student Activities:

A. Frame and scribe parts for welding and cutting
B. Use measuring techniques on parts
C. Produce a drawing which includes weld symbols

PRACTICAL APPLICATION:

This lesson will cover where to look for a specific measurement on a blueprint and how to determine tolerance from the information given on a blueprint. The students will have the opportunity to demonstrate understanding by following the instructions provided by the blueprint or drawing.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The instructor will emphasize the benefits of precise drawing interpretation. The need to depict proper layout of work will be reinforced in the class. The types of lines, angles, and measurement points contain important reference for the welder.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H2) dealing with describing alphabet of lines.

WLD-H1-HO1
Understand Parts of Blueprint
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Introduce related terms and definitions;
B. Define proper terms and definitions;
C. Define lines, dimensions and notes;
D. Perform metric conversions;
E. Discuss orthographic views;
F. Interpret blueprint information; and,
G. Depict proper layout.

PRESENTATION OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup
B. Demonstrate how to use the reference on a blueprint
C. Lines, dimensions and notes
D. Demonstrate how to scribe a line using a square and a protractor
E. Illustrate how to use the print to find angles
F. Define the following: precision, reliability and accuracy
G. Define tolerance and how to find it on a blueprint
H. Metrics for welders
I. Demonstrate semi-precision measurements techniques
J. Discuss the importance of the tolerance
K. Discriminate between accepted measurement procedures and improper measurement procedures
L. Explain calibration requirements of various precision instruments
M. Illustrate where to locate measurements

Student Activities:

A. Frame and scribe parts for welding and cutting
B. Use measuring techniques on parts
C. Produce a drawing which includes weld symbols

WLD-H1-HO2
Understand Parts of Blueprint
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
   A. General notes
   B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
   A. General notes applied
      1. Title strip/title block
      2. Parts list/bill of material
   B. Interpret general notes
      1. Including material
      2. General tolerances
      3. Heat treatment
      4. Pattern information
      5. Processes of manufacture
      6. Requirements of the product
   C. Interpret specific notes
      1. Apply to specific operations
      2. Apply to specific processes of manufacture
      3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
   A. Identify organizations that determine dimension standards
      1. American National Standards Institutes (ANSI)
      2. International Standards Organization (ISO)
   B. Determine dimensions on a drawing
      1. Size dimensions
      2. Location dimensions
   C. Applying dimensions on a drawing
      1. Scale of drawing
      2. Techniques of dimensioning
      3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
    - 1. General tolerances
    - 2. Limit dimensioning
    - 3. Plus and minus dimensioning
        - a. Unilateral system
        - b. Bilateral system
    - 4. Single-limit dimensioning
    - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
    - 1. Clearance fit
    - 2. Interference fit
    - 3. Transition fit
    - 4. Line fit
- B. Limits and fits for cylindrical parts
    - 1. Running or sliding clearance fits
    - 2. Locational clearance fits
    - 3. Transition clearance interference fits
    - 4. Locational interference fits
    - 5. Force or shrink fits

WLD-H1-HO3
Understand Parts of Blueprint
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry
III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols
    1. Straightness

    - 2. Flatness
    - 3. Circularity
    - 4. Cylindrical
- IV. Explain and Use Profile Tolerances
  - A. Explain profile tolerance
  - B. Identify and use profile tolerance symbols
    - 1. Profile of a line
    - 2. Profile of a surface
    - 3. Profile of an arc
    - 4. Profile of irregular curves
    - 5. Profile of coplanar surfaces
- V. Explain and Use Tolerances of Orientation
  - A. Explain orientation tolerances
  - B. Identify and use orientation tolerance symbols
    - 1. Parallelism
    - 2. Perpendicularity
    - 3. Angularity
- VI. Explain and Use Runout Tolerances
  - A. Explain runouts
    - 1. Circular
    - 2. Total
  - B. Identify and use runout tolerances symbols
    - 1. Circular
    - 2. Total
- VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  - A. Maximum Material Condition (MMC)
  - B. Regardless of Feature Size (RFS)
  - C. Least Material Condition (LMC)
  - D. Datum feature symbol
  - E. Datum reference frame concept
    - 1. Primary datum plane
    - 2. Secondary datum plane
    - 3. Tertiary datum plane
  - F. Datum target symbol
    - 1. Target point
    - 2. Target line
    - 3. Target area
- VIII. Explain and Use the Feature Control Frame
  - A. Explain feature control frame
  - B. Explain the compartments of a feature control frame
    - 1. Geometric characteristic symbol
    - 2. Geometric tolerance
    - 3. Zone descriptor
    - 4. Material condition symbol
    - 5. Primary datum reference

    6. Secondary datum reference
    7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
  A. Explain and use additional modifying symbols.
    1. Diameter
    2. Radius R
    3 Reference ( )
    4. Counterbore/spotface L/
    5. Square
    6. Dimension origin O
    7 Slope
    8. Projected tolerance zone
    9. Spherical diameter
    10. Spherical radius
    11. Arc length
    12. Counter sink
    13. Depth
    14. Conical taper
    15. Place, times, or by
    16. Basic dimension

WELDER SERIES

MASTER Technical Module No. WLD-H02

SUBJECT: **WELDING TECHNICIAN** **TIME: 5 HOURS**

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Describe Alphabet of Lines

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify orthographic views;
B. Understand standard drawing lines and symbols; and,
C. Interpret blueprint information.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Classroom handouts
MASTER Handout No. 1 (WLD-H2-HO1)
MASTER Handout No. 2 (WLD-H2-HO2)
MASTER Handout No. 3 (WLD-H2-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Blueprint Reading for Welders, Bennett, A. E. and Siy, L. J., Delmar Publishers, Latest Edition
Welding Blueprints & Symbols, Stinchcomb, Craig, Prentice Hall, (ISBN 0-13-436296-9), Latest Edition

---

STUDENT PREPARATION:

The purpose of this program is to assist the student to improve skill levels for employment as a welding technician, or to provide supplemental training for persons needing instruction for interpreting drawing lines, views, or symbols.

Students should have previously completed the following Technical Modules:
WLD-H1 "Understand Parts of Blueprint"

INTRODUCTION:

The Course Introduction Will Include:

- The importance of precise use and interpretation of lines on drawings
- A class demonstration of effective drawing and interpretation techniques
- A discussion on methods of leading to an increase of skill and knowledge in order to be diversified, and a more valuable employee

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Present basic lines and views
B. Locations and alignment of views
C. Review print notes, dimensions and symbols
  1) Interpret AWS standard welding symbols
  2) List essential components found in general notes on drawing
  3) Determine acceptable tolerances for drawing
  4) Determine code requirements, process and procedure requirements required by drawing
  5) Interpret multi-view drawings
  6) Work from drawings
D. Identify basic layouts of drawings
E. Interpret drawing lines, views, and symbols
F. Interpret welding symbols
G. Convert metric to English
H. Understand print specifications
I. List assembly procedure per print
J. Understand various types of welding prints
K. Visualize final weldment from print
L. List flaws and mistakes on drawings
M. Interpret AWS standard welding symbols

Student Activities:

A. Use basic sketching techniques
B. Frame and scribe parts for welding and cutting

C. Use measuring techniques on parts
D. Produce a drawing which includes weld symbols

PRACTICAL APPLICATION:

This lesson will cover where to look for specific measurements on a blueprint and how to describe tolerance with the information specified on a blueprint. The students will have the opportunity to sketch or draw part layout and explain the work to be performed, based upon the drawing information.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The instructor will emphasize the benefits of using proper drawing symbols and measurement specifications that will make the welder understand the job requirements and produce quality welded parts.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H3) dealing with demonstrating tape reading and measurement techniques.

WLD-H2-HO1

Describe Alphabet of Lines

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify orthographic views;
B. Understand standard drawing lines and symbols; and,
C. Interpret blueprint information.

MODULE OUTLINE:

Instructional Topics:

A. Present basic lines and views
B. Locations and alignment of views
C. Review print notes, dimensions and symbols
  1) Interpret AWS standard welding symbols
  2) List essential components found in general notes on drawing
  3) Determine acceptable tolerances for drawing
  4) Determine code requirements, process and procedure requirements required by drawing
  5) Interpret multi-view drawings
  6) Work from drawings
D. Identify basic layouts of drawings
E. Interpret drawing lines, views, and symbols
F. Interpret welding symbols
G. Convert metric to English
H. Understand print specifications
I. List assembly procedure per print
J. Understand various types of welding prints
K. Visualize final weldment from print
L. List flaws and mistakes on drawings
M. Interpret AWS standard welding symbols

Student Activities:

A. Use basic sketching techniques
B. Frame and scribe parts for welding and cutting
C. Use measuring techniques on parts
D. Produce a drawing which includes weld symbols

WLD-H2-HO2
Describe Alphabet of Lines
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
  A. General notes
  B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
  A. General notes applied
    1. Title strip/title block
    2. Parts list/bill of material
  B. Interpret general notes
    1. Including material
    2. General tolerances
    3. Heat treatment
    4. Pattern information
    5. Processes of manufacture
    6. Requirements of the product
  C. Interpret specific notes
    1. Apply to specific operations
    2. Apply to specific processes of manufacture
    3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
  A. Identify organizations that determine dimension standards
    1. American National Standards Institutes (ANSI)
    2. International Standards Organization (ISO)
  B. Determine dimensions on a drawing
    1. Size dimensions
    2. Location dimensions
  C. Applying dimensions on a drawing
    1. Scale of drawing
    2. Techniques of dimensioning
    3. Placement of dimensions

    4. Choice of dimensions
    5. Types of lines used in the dimensioning process
    6. Arrowheads used on drawings
    7. Leaders used on drawings
    8. Dimensioning systems
        a. Fractional
        b. Decimal
        c. Metric
        d. Combination dimensioning
    9. Dimension figures
    10. Direction of dimension figures
        a. Unidirectional system
        b. Aligned system
    11. Dimensioning angles
    12. Dimensioning arcs
    13. Dimensioning fillets and rounds
    14. Identify surfaces to be machined
    15. Contour dimensioning
    16. Dimensioning of curves
    17. Dimensioning of rounded-end shapes
    18. Dimensioning of threads
    19. Dimensioning of tapers
    20. Dimensioning of chamfers
    21. Dimensioning shaft centers
    22. Dimensioning keyways
    23. Dimensioning knurls
        a. Diamond
        b. Straight
    24. Dimensioning along curved surfaces
    25. Tabular dimensions
    26. Dimensioning standards
    27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
  A. Traditional terms used to describe various shapes, processes, and sizes
  B. Identify abbreviations used to describe various shapes, processes, and size
  C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
  A. Identify tolerances or limits
    1. Nominal size
    2. Basic size or dimension
    3. Actual size
    4. Tolerance
    5. Limits
    6. Allowance

- B. Methods of expressing tolerances
    - 1. General tolerances
    - 2. Limit dimensioning
    - 3. Plus and minus dimensioning
        - a. Unilateral system
        - b. Bilateral system
    - 4. Single-limit dimensioning
    - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
    - 1. Clearance fit
    - 2. Interference fit
    - 3. Transition fit
    - 4. Line fit
- B. Limits and fits for cylindrical parts
    - 1. Running or sliding clearance fits
    - 2. Locational clearance fits
    - 3. Transition clearance interference fits
    - 4. Locational interference fits
    - 5. Force or shrink fits

WLD-H2-HO3
Describe Alphabet of Lines
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry
III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols
    1. Straightness

- 2. Flatness
- 3. Circularity
- 4. Cylindrical

- IV. Explain and Use Profile Tolerances
  - A. Explain profile tolerance
  - B. Identify and use profile tolerance symbols
    - 1. Profile of a line
    - 2. Profile of a surface
    - 3. Profile of an arc
    - 4. Profile of irregular curves
    - 5. Profile of coplanar surfaces
- V. Explain and Use Tolerances of Orientation
  - A. Explain orientation tolerances
  - B. Identify and use orientation tolerance symbols
    - 1. Parallelism
    - 2. Perpendicularity
    - 3. Angularity
- VI. Explain and Use Runout Tolerances
  - A. Explain runouts
    - 1. Circular
    - 2. Total
  - B. Identify and use runout tolerances symbols
    - 1. Circular
    - 2. Total
- VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  - A. Maximum Material Condition (MMC)
  - B. Regardless of Feature Size (RFS)
  - C. Least Material Condition (LMC)
  - D. Datum feature symbol
  - E. Datum reference frame concept
    - 1. Primary datum plane
    - 2. Secondary datum plane
    - 3. Tertiary datum plane
  - F. Datum target symbol
    - 1. Target point
    - 2. Target line
    - 3. Target area
- VIII. Explain and Use the Feature Control Frame
  - A. Explain feature control frame
  - B. Explain the compartments of a feature control frame
    - 1. Geometric characteristic symbol
    - 2. Geometric tolerance
    - 3. Zone descriptor
    - 4. Material condition symbol
    - 5. Primary datum reference

        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WELDER SERIES

MASTER Technical Module No. WLD-H03

SUBJECT: WELDING TECHNICIAN TIME: 5 HOURS

- **DUTY: BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Demonstrate Tape Reading and Measurement Techniques

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the function of measurement tools;
B. Demonstrate the capabilities of shop lay-out tools; and,
C. Understand related terms and definitions.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Steel rule, tape, micrometer, and vernier caliper for each student
Classroom handouts
MASTER Handout No. 1 (WLD-H3-HO1)
MASTER Handout No. 2 (WLD-H3-HO2)
MASTER Handout No. 3 (WLD-H3-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Blueprint Reading for Welders, Bennett, A. E. and Siy, L. J., Delmar Publishers, Latest Edition

Welding Blueprints & Symbols, Stinchcomb, Craig, Prentice Hall, (ISBN 0-13-436296-9), Latest Edition

STUDENT PREPARATION:

This module prepares the student to measure dimensions that are specified in a sketch or engineering drawing, understanding the concept of tolerance, and produce a quality product.

Students should have previously completed the following Technical Modules:

WLD-H2 "Describe Alphabet of lines"

INTRODUCTION:

The Course Introduction will Include:

- The importance of measurement tool applications, proper selection and the use of measurement tools
- A class demonstration of techniques
- A discussion on methods leading to an increase of skill and knowledge in the use of measurement tools

PRESENTATION OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup
B. Demonstrate how to use the reference on a blueprint
C. Demonstrate how to scribe a line using a square and a protractor
D. Illustrate how to use the print to find angles
E. Define the following: precision, reliability and accuracy
F. Define tolerance and how to find it on a blueprint
G. Demonstrate semi-precision measurements techniques
H. Demonstrate use of steel rules, tapes, micrometers, and vernier calipers
I. Discuss the importance of the tolerance
J. Discriminate between accepted measurement procedures and improper measurement procedures
K. Explain calibration requirements of various precision instruments
L. Illustrate where to locate measurements

Student Activities:

A. Frame and scribe parts for welding and cutting
B. Use measuring techniques on parts
C. Practice use of measurement tools with measurement exercises assigned by the instructor.
D. Interpret engineering drawings provided by the instructor

PRACTICAL APPLICATION:

This lesson will cover where to look for a specific measurement on a blueprint and explain how to determine tolerance from the information given on a blueprint. The students will have the opportunity to use precision measuring tools to take measurements and to layout test coupons.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The instructor will emphasize the benefit of using appropriate measurement tools for the job. The ability to use precision tools will require continued practice with measurement tools frequently used by welders. Review welding symbols and provide the students with a copy of AWS weld symbols.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H4) dealing with using framing square to square parts.

WLD-H3-HO1
Demonstrate Tape Reading and Measurement Techniques
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- A. Understand the function of measurement tools;
- B. Demonstrate the capabilities of shop lay-out tools; and,
- C. Understand related terms and definitions.

PRESENTATION OUTLINE:

Instructional Topics:
- A. Review the use of jigs and fixtures in layout and fitup
- B. Demonstrate how to use the reference on a blueprint
- C. Demonstrate how to scribe a line using a square and a protractor
- D. Illustrate how to use the print to find angles
- E. Define the following: precision, reliability and accuracy
- F. Define tolerance and how to find it on a blueprint
- G. Demonstrate semi-precision measurements techniques
- H. Demonstrate use of steel rules, tapes, micrometers, and vernier calipers
- I. Discuss the importance of the tolerance
- J. Discriminate between accepted measurement procedures and improper measurement procedures
- K. Explain calibration requirements of various precision instruments
- L. Illustrate where to locate measurements

Student Activities:
- A. Frame and scribe parts for welding and cutting
- B. Use measuring techniques on parts
- C. Practice use of measurement tools with measurement exercises assigned by the instructor
- D. Interpret engineering drawings provided by the instructor

WLD-H3-HO2
Demonstrate Tape Reading and Measurement Techniques
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning
        3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
    - 1. General tolerances
    - 2. Limit dimensioning
    - 3. Plus and minus dimensioning
        - a. Unilateral system
        - b. Bilateral system
    - 4. Single-limit dimensioning
    - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
    - 1. Clearance fit
    - 2. Interference fit
    - 3. Transition fit
    - 4. Line fit
- B. Limits and fits for cylindrical parts
    - 1. Running or sliding clearance fits
    - 2. Locational clearance fits
    - 3. Transition clearance interference fits
    - 4. Locational interference fits
    - 5. Force or shrink fits

WLD-H3-HO3
Demonstrate Tape Reading and Measurement Techniques
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units

II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry

III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols
    1. Straightness

        - 2. Flatness
        - 3. Circularity
        - 4. Cylindrical
- IV. Explain and Use Profile Tolerances
    - A. Explain profile tolerance
    - B. Identify and use profile tolerance symbols
        - 1. Profile of a line
        - 2. Profile of a surface
        - 3. Profile of an arc
        - 4. Profile of irregular curves
        - 5. Profile of coplanar surfaces
- V. Explain and Use Tolerances of Orientation
    - A. Explain orientation tolerances
    - B. Identify and use orientation tolerance symbols
        - 1. Parallelism
        - 2. Perpendicularity
        - 3. Angularity
- VI. Explain and Use Runout Tolerances
    - A. Explain runouts
        - 1. Circular
        - 2. Total
    - B. Identify and use runout tolerances symbols
        - 1. Circular
        - 2. Total
- VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    - A. Maximum Material Condition (MMC)
    - B. Regardless of Feature Size (RFS)
    - C. Least Material Condition (LMC)
    - D. Datum feature symbol
    - E. Datum reference frame concept
        - 1. Primary datum plane
        - 2. Secondary datum plane
        - 3. Tertiary datum plane
    - F. Datum target symbol
        - 1. Target point
        - 2. Target line
        - 3. Target area
- VIII. Explain and Use the Feature Control Frame
    - A. Explain feature control frame
    - B. Explain the compartments of a feature control frame
        - 1. Geometric characteristic symbol
        - 2. Geometric tolerance
        - 3. Zone descriptor
        - 4. Material condition symbol
        - 5. Primary datum reference

        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WELDER SERIES

MASTER Technical Module No. WLD-H04

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Use Framing Square to Square Parts

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate the use of shop lay-out tools in a safe manner;
B. Understand the function of shop lay-out tools; and,
C. Demonstrate the capabilities of shop lay-out tools.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Framing square and shop layout tools
Classroom handouts
MASTER Handout No. 1 (WLD-H4-HO1)
MASTER Handout No. 2 (WLD-H4-HO2)
MASTER Handout No. 3 (WLD-H4-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Blueprint Reading for Welders, Bennett, A. E. and Siy, L. J., Delmar Publishers, Latest Edition

Welding Blueprints & Symbols, Stinchcomb, Craig, Prentice Hall, (ISBN 0-13-436296-9), Latest Edition

---

STUDENT PREPARATION:

The purpose of this program is to assist the student in the use of framing square measurement equipment to perform structural layout and fit-up. Supplemental training can also be presented to persons previously or currently employed in welding occupations.

Students should have previously completed the following Technical Modules:

WLD-H3 "Demonstrate Tape Reading and Measurement Techniques"

INTRODUCTION:

The Course Introduction will Include:

- The purpose of structural layout and fit-up
- A class demonstration of effective structural layout and framing techniques
- A discussion on methods of leading to an increase of skill and knowledge in the occupational area

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup
B. Demonstrate how to use references on a blueprint
C. Demonstrate the application of the framing square
D. Demonstrate how to scribe a line using a square and a protractor
E. Illustrate how to use the print to find angles
F. Define the following: precision, reliability and accuracy
G. Define tolerance and how to find it on a blueprint
H. Demonstrate semi-precision measurements techniques
I. Understand the difference between accepted measurement procedures and improper measurement procedures
J. Illustrate where to locate measurements

Student Activities:

A. Frame and scribe parts for welding and cutting
B. Use measuring techniques on parts
C. Layout a welding job with framing square, jigs, and fixtures

---

PRACTICAL APPLICATION:

This lesson will cover the use of framing square, jigs, and fixtures in laying out the work in a production environment.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

In this module, the instructor emphasizes the benefits of using the framing square, jigs, and fixtures for production and quality.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H5) dealing with using level and other devices to verify layout.

WLD-H4-HO1
Use Framing Square to Square Parts
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Demonstrate the use of shop lay-out tools in a safe manner;
B. Understand the function of shop lay-out tools; and,
C. Demonstrate the capabilities of shop lay-out tools.

MODULE OUTLINE:

Instructional Topics:
A. Review the use of jigs and fixtures in layout and fitup
B. Demonstrate how to use references on a blueprint
C. Demonstrate the application of the framing square
D. Demonstrate how to scribe a line using a square and a protractor
E. Illustrate how to use the print to find angles
F. Define the following: precision, reliability and accuracy
G. Define tolerance and how to find it on a blueprint
H. Demonstrate semi-precision measurements techniques
I. Understand the difference between accepted measurement procedures and improper measurement procedures
J. Illustrate where to locate measurements

Student Activities:
A. Frame and scribe parts for welding and cutting
B. Use measuring techniques on parts
C. Layout a welding job with framing square, jigs, and fixtures

WLD-H4-HO2
Use Framing Square to Square Parts
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning
        3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
    - 1. General tolerances
    - 2. Limit dimensioning
    - 3. Plus and minus dimensioning
        - a. Unilateral system
        - b. Bilateral system
    - 4. Single-limit dimensioning
    - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
    - 1. Clearance fit
    - 2. Interference fit
    - 3. Transition fit
    - 4. Line fit
- B. Limits and fits for cylindrical parts
    - 1. Running or sliding clearance fits
    - 2. Locational clearance fits
    - 3. Transition clearance interference fits
    - 4. Locational interference fits
    - 5. Force or shrink fits

WLD-H4-HO3
Use Framing Square to Square Parts
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
    A. General/conventional tolerancing
        1. Definitions of general/conventional tolerancing
            a. Dimension
            b. Reference dimension
            c. Feature
            d. Feature of size
            e. Actual size
            f. Stock size
        2. Maximum material condition
        3. Least material condition
        4. Basic fits
        5. Clearance fit
        6. Allowance
        7. Clearance
        8. Force fit
    B. Geometric dimensioning and tolerancing
        1. Definition of geometric dimensioning and tolerancing
        2. Dimensioning rules
        3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
    A. Explain positional / location tolerances
    B. Identify and use geometric position tolerancing symbols
        1. Position
        2. Concentricity
        3. Symmetry
III. Explain and Use Tolerances of Form Symbols
    A. Explain form tolerances
    B. Identify and use tolerances of form symbols
        1. Straightness

      2. Flatness
      3. Circularity
      4. Cylindrical

IV. Explain and Use Profile Tolerances
   A. Explain profile tolerance
   B. Identify and use profile tolerance symbols
      1. Profile of a line
      2. Profile of a surface
      3. Profile of an arc
      4. Profile of irregular curves
      5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
   A. Explain orientation tolerances
   B. Identify and use orientation tolerance symbols
      1. Parallelism
      2. Perpendicularity
      3. Angularity

VI. Explain and Use Runout Tolerances
   A. Explain runouts
      1. Circular
      2. Total
   B. Identify and use runout tolerances symbols
      1. Circular
      2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
   A. Maximum Material Condition (MMC)
   B. Regardless of Feature Size (RFS)
   C. Least Material Condition (LMC)
   D. Datum feature symbol
   E. Datum reference frame concept
      1. Primary datum plane
      2. Secondary datum plane
      3. Tertiary datum plane
   F. Datum target symbol
      1. Target point
      2. Target line
      3. Target area

VIII. Explain and Use the Feature Control Frame
   A. Explain feature control frame
   B. Explain the compartments of a feature control frame
      1. Geometric characteristic symbol
      2. Geometric tolerance
      3. Zone descriptor
      4. Material condition symbol
      5. Primary datum reference

    6. Secondary datum reference
    7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

  A. Explain and use additional modifying symbols.
    1. Diameter
    2. Radius R
    3. Reference ( )
    4. Counterbore/spotface L/
    5. Square
    6. Dimension origin O
    7. Slope
    8. Projected tolerance zone
    9. Spherical diameter
    10. Spherical radius
    11. Arc length
    12. Counter sink
    13. Depth
    14. Conical taper
    15. Place, times, or by
    16. Basic dimension

WELDER SERIES

MASTER Technical Module No. WLD-H05

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Use Level and Other Devices to Verify Layout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate the use and care of shop lay-out tools; and,

B. Perform leveling methods related to part lay-out for sheet metal, structural and pipe fabrication.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Levels, squaring tools, and measurement tools
Classroom handouts
MASTER Handout No. 1 (WLD-H5-HO1)
MASTER Handout No. 2 (WLD-H5-HO2)
MASTER Handout No. 3 (WLD-H5-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Blueprint Reading for Welders, Bennett, A. E. and Siy, L. J., Delmar Publishers, Latest Edition

Welding Blueprints & Symbols, Stinchcomb, Craig, Prentice Hall, (ISBN 0-13-436296-9), Latest Edition

---

STUDENT PREPARATION:

The purpose of this module is to assist the student in the use of levels, alignment devices, and measurement equipment to improve skills in organization of the workplace for welding operations.

Students should have previously completed the following Technical Modules:

WLD-H4 "Use Framing Square to Square Parts"

INTRODUCTION:

The Course Introduction will Include:

- The importance of leveling, squaring, and measurement of the work prior to welding
- A class demonstration of effective leveling, squaring, and fitup techniques
- A discussion on methods of leading to an increase of skill and knowledge in order to be diversified, and a more valuable employee

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup
B. Demonstrate how to use levels and squaring tools
C. Illustrate how to use the print to establishing layout
D. Demonstrate semi-precision measurements techniques
E. Discuss the importance of fixturing to insure alignment

Student Activities:

A. Use of levels and squaring tools
B. Use measuring techniques on parts
C. Produce a sketch or drawing of the fit-up workplace

PRACTICAL APPLICATION:

This lesson has application for job layout as the fit-up of materials for welding is planned and accomplished.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The instructor emphasizes the benefits of using levels and fixtures for alignment to insure production and quality. The ability to plan the work will create an attitude for precision.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H6) dealing with understanding and interpreting shop drawings for precise layout.

WLD-H5-HO1
Use Level and Other Devices to Verify Layout
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate the use and care of shop lay-out tools; and,

B. Perform leveling methods related to part lay-out for sheet metal, structural and pipe fabrication.

MODULE OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup

B. Demonstrate how to use levels and squaring tools

C. Illustrate how to use the print to establishing layout

D. Demonstrate semi-precision measurements techniques

E. Discuss the importance of fixturing to insure alignment

Student Activities:

A. Use of levels and squaring tools

B. Use measuring techniques on parts

C. Produce a sketch or drawing of the fit-up workplace

WLD-H5-HO2
Use Level and Other Devices to Verify Layout
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
  A. General notes
  B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
  A. General notes applied
    1. Title strip/title block
    2. Parts list/bill of material
  B. Interpret general notes
    1. Including material
    2. General tolerances
    3. Heat treatment
    4. Pattern information
    5. Processes of manufacture
    6. Requirements of the product
  C. Interpret specific notes
    1. Apply to specific operations
    2. Apply to specific processes of manufacture
    3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
  A. Identify organizations that determine dimension standards
    1. American National Standards Institutes (ANSI)
    2. International Standards Organization (ISO)
  B. Determine dimensions on a drawing
    1. Size dimensions
    2. Location dimensions
  C. Applying dimensions on a drawing
    1. Scale of drawing
    2. Techniques of dimensioning
    3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning
IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations
V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
  - 1. General tolerances
  - 2. Limit dimensioning
  - 3. Plus and minus dimensioning
    - a. Unilateral system
    - b. Bilateral system
  - 4. Single-limit dimensioning
  - 5. Angular tolerances
- VI. Identify ANSI Limits and Fits
  - A. Fits between mating parts
    - 1. Clearance fit
    - 2. Interference fit
    - 3. Transition fit
    - 4. Line fit
  - B. Limits and fits for cylindrical parts
    - 1. Running or sliding clearance fits
    - 2. Locational clearance fits
    - 3. Transition clearance interference fits
    - 4. Locational interference fits
    - 5. Force or shrink fits

WLD-H5-HO3
Use Level and Other Devices to Verify Layout
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Distinguish between conventional and geometric dimensioning and tolerancing;
- b. Explain and use geometric positional tolerancing and symbols;
- c. Explain and use tolerances of form and symbols;
- d. Explain and use the feature control symbol; and,
- e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

- I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  - A. General/conventional tolerancing
    - 1. Definitions of general/conventional tolerancing
      - a. Dimension
      - b. Reference dimension
      - c. Feature
      - d. Feature of size
      - e. Actual size
      - f. Stock size
    - 2. Maximum material condition
    - 3. Least material condition
    - 4. Basic fits
    - 5. Clearance fit
    - 6. Allowance
    - 7. Clearance
    - 8. Force fit
  - B. Geometric dimensioning and tolerancing
    - 1. Definition of geometric dimensioning and tolerancing
    - 2. Dimensioning rules
    - 3. Dimensioning units
- II. Explain and Use Geometric Positional Tolerancing and Symbols
  - A. Explain positional / location tolerances
  - B. Identify and use geometric position tolerancing symbols
    - 1. Position
    - 2. Concentricity
    - 3. Symmetry
- III. Explain and Use Tolerances of Form Symbols
  - A. Explain form tolerances
  - B. Identify and use tolerances of form symbols
    - 1. Straightness

        - 2. Flatness
        - 3. Circularity
        - 4. Cylindrical
- IV. Explain and Use Profile Tolerances
    - A. Explain profile tolerance
    - B. Identify and use profile tolerance symbols
        - 1. Profile of a line
        - 2. Profile of a surface
        - 3. Profile of an arc
        - 4. Profile of irregular curves
        - 5. Profile of coplanar surfaces
- V. Explain and Use Tolerances of Orientation
    - A. Explain orientation tolerances
    - B. Identify and use orientation tolerance symbols
        - 1. Parallelism
        - 2. Perpendicularity
        - 3. Angularity
- VI. Explain and Use Runout Tolerances
    - A. Explain runouts
        - 1. Circular
        - 2. Total
    - B. Identify and use runout tolerances symbols
        - 1. Circular
        - 2. Total
- VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    - A. Maximum Material Condition (MMC)
    - B. Regardless of Feature Size (RFS)
    - C. Least Material Condition (LMC)
    - D. Datum feature symbol
    - E. Datum reference frame concept
        - 1. Primary datum plane
        - 2. Secondary datum plane
        - 3. Tertiary datum plane
    - F. Datum target symbol
        - 1. Target point
        - 2. Target line
        - 3. Target area
- VIII. Explain and Use the Feature Control Frame
    - A. Explain feature control frame
    - B. Explain the compartments of a feature control frame
        - 1. Geometric characteristic symbol
        - 2. Geometric tolerance
        - 3. Zone descriptor
        - 4. Material condition symbol
        - 5. Primary datum reference

6. Secondary datum reference
7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

A. Explain and use additional modifying symbols.

1. Diameter
2. Radius R
3. Reference ( )
4. Counterbore/spotface L/
5. Square
6. Dimension origin O
7. Slope
8. Projected tolerance zone
9. Spherical diameter
10. Spherical radius
11. Arc length
12. Counter sink
13. Depth
14. Conical taper
15. Place, times, or by
16. Basic dimension

WELDER SERIES

MASTER Technical Module No. WLD-H06

SUBJECT: WELDING TECHNICIAN TIME: 5 HOURS

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Understand and Interpret Shop Drawings for Precise Layout

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand concept related to work area preparation;
B. Understand drawing, sketching and specifications; and,
C. Interpret shop drawings.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Classroom handouts
MASTER Handout No. 1 (WLD-H6-HO1)
MASTER Handout No. 2 (WLD-H6-HO2)
MASTER Handout No. 3 (WLD-H6-HO3)
MASTER Handout No. 4 (WLD-H6-HO4)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Blueprint Reading for Welders, Bennett, A. E. and Siy, L. J., Delmar Publishers, Latest Edition

Welding Blueprints & Symbols, Stinchcomb, Craig, Prentice Hall,
(ISBN 0-13-436296-9), Latest Edition

STUDENT PREPARATION:

The purpose of this module is to assist the student in interpreting and fully understanding shop drawings for precise layout.

Students should have previously completed the following Technical Modules:
WLD-H5 "Use Level and Other Devices to Verify Layout"

INTRODUCTION:

The Course Introduction will Include:
- An overview of the interpretation of methods and techniques needed for quality production welding
- A class demonstration of effective layout, fitup and measurement techniques used in production environment

---

PRESENTATION OUTLINE:

Instructional Topics:
A. Interpretation of linear and angular dimensions
B. Use of fractional dimensions and decimal fractions
C. Terms for hole preparation - drill, ream, or flame cut
D. Dimensioning chambers and bevels
E. Dimensioning radius and arc
F. Use of tolerance dimensions
G. Use of thread dimensions
H. Symbols or geometric tolerancing and dimensioning

Student Activities:
A. Interpret engineering drawings by answering questions in each area represented
B. Prepare a sketch that will be critiqued by others in the class for specific meaning and clarity

---

PRACTICAL APPLICATION:

This lesson will cover where to look for a specific measurements on a drawing and how to determine tolerance from the information given on the drawing.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

Drawing interpretation is a special skill needed by the professional welder. He must insure the finished product meets all specifications and that no re-work is required to additional cost, time and money.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H7) dealing with demonstrating knowledge of welding symbols.

WLD-H6-HO1
Understand and Interpret Shop Drawings for Precise Layout
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand concept related to work area preparation;
B. Understand drawing, sketching and specifications; and,
C. Interpret shop drawings.

MODULE OUTLINE:

Instructional Topics:

A. Interpretation of linear and angular dimensions
B. Use of fractional dimensions and decimal fractions
C. Terms for hole preparation - drill, ream, or flame cut .
D. Dimensioning chambers and bevels
E. Dimensioning radius and arc
F. Use of tolerance dimensions
G. Use of thread dimensions
H. Symbols or geometric tolerancing and dimensioning

Student Activities:

A. Interpret engineering drawings by answering questions in each area represented
B. Prepare a sketch that will be critiqued by others in the class for specific meaning and clarity

WLD-H6-HO2

Understand and Interpret Shop Drawings for Precise Layout

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
  A. General notes
  B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
  A. General notes applied
    1. Title strip/title block
    2. Parts list/bill of material
  B. Interpret general notes
    1. Including material
    2. General tolerances
    3. Heat treatment
    4. Pattern information
    5. Processes of manufacture
    6. Requirements of the product
  C. Interpret specific notes
    1. Apply to specific operations
    2. Apply to specific processes of manufacture
    3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
  A. Identify organizations that determine dimension standards
    1. American National Standards Institutes (ANSI)
    2. International Standards Organization (ISO)
  B. Determine dimensions on a drawing
    1. Size dimensions
    2. Location dimensions
  C. Applying dimensions on a drawing
    1. Scale of drawing
    2. Techniques of dimensioning
    3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning
IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations
V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
  - 1. General tolerances
  - 2. Limit dimensioning
  - 3. Plus and minus dimensioning
    - a. Unilateral system
    - b. Bilateral system
  - 4. Single-limit dimensioning
  - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
  - 1. Clearance fit
  - 2. Interference fit
  - 3. Transition fit
  - 4. Line fit
- B. Limits and fits for cylindrical parts
  - 1. Running or sliding clearance fits
  - 2. Locational clearance fits
  - 3. Transition clearance interference fits
  - 4. Locational interference fits
  - 5. Force or shrink fits

WLD-H6-HO3
Understand and Interpret Shop Drawings for Precise Layout
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry
III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols
    1. Straightness

        2. Flatness
        3. Circularity
        4. Cylindrical

IV. Explain and Use Profile Tolerances
    A. Explain profile tolerance
    B. Identify and use profile tolerance symbols
        1. Profile of a line
        2. Profile of a surface
        3. Profile of an arc
        4. Profile of irregular curves
        5. Profile of coplanar surfaces

V: Explain and Use Tolerances of Orientation
    A. Explain orientation tolerances
    B. Identify and use orientation tolerance symbols
        1. Parallelism
        2. Perpendicularity
        3. Angularity

VI. Explain and Use Runout Tolerances
    A. Explain runouts
        1. Circular
        2. Total
    B. Identify and use runout tolerances symbols
        1. Circular
        2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    A. Maximum Material Condition (MMC)
    B. Regardless of Feature Size (RFS)
    C. Least Material Condition (LMC)
    D. Datum feature symbol
    E. Datum reference frame concept
        1. Primary datum plane
        2. Secondary datum plane
        3. Tertiary datum plane
    F. Datum target symbol
        1. Target point
        2. Target line
        3. Target area

VIII. Explain and Use the Feature Control Frame
    A. Explain feature control frame
    B. Explain the compartments of a feature control frame
        1. Geometric characteristic symbol
        2. Geometric tolerance
        3. Zone descriptor
        4. Material condition symbol
        5. Primary datum reference

        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WLD-H6-HO4

Understand and Interpret Shop Drawings for Precise layout

Attachment 4: **MASTER** Handout No. 4

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify types of drawings;
b. Identify parts of a drawing and list components of each;
c. Identify types of lines on a drawing;
d. List and describe the different views found on a drawing;
e. List and apply the three primary planes of projection;
f. List and apply the six principal views;
g. Apply auxiliary views; and,
h. Apply sectional views.

Module Outline:

I. Interpret and Understand Basic Layout of Drawings
  A. ANSI & ISO sheet size layout
  B. ANSI & ISO forms of lettering arrangements
II. Interpret and Understand Types of Drawings
  A. Orthographic and multi-view projection
  B. Perspective or central projection
  C. Oblique projection
  D. Axonometric projection
III. Identify Parts of a Blue Print/Drawing and List Components of Each
  A. Body
  B. Title block
    1. Drawing number
    2. Drawing title
    3. Scale
    4. Signatures
    5. Job number
    6. Material list number
    7. Reference drawings
    8. Distribution section
    9. Revision
    10. Work order number
  C. Bill of Materials
    1. Piece mark number
    2. Number of pieces required for each piece mark
    3. Description of materials
    4. Traceability requirements
    5. Material specifications

    - 6. Length
    - 7. Gross weight
    - 8. Total weight
- IV. Identify Types of Lines on a Drawing
  - A. Visible line
  - B. Hidden line
  - C. Center line
  - D. Section line
  - E. Dimension line
  - F. Extension line
  - G. Leaders line
  - H. Cutting plane/viewing plane line
  - I. Short-break line
  - J. Long-break line
  - K. Phantom line
  - L. Stitch line
  - M. Chain line
  - N. Cylindrical break/conventional break lines
- V. List and Describe the Different Views Found on a Drawing
  - A. One view
    - 1. Sphere
    - 2. Plate
  - B. Two view
    - 1. Cylinder
    - 2. Rectangle
  - C. Three view
    - 1. Pyramids
    - 2. Multi-view projection
- VI. List and Apply the Three Primary Planes of Projection
  - A. Frontal projection plane
  - B. Profile projection plane
    - 1. Right side
    - 2. Left side
  - C. Horizontal projection plane
- VII. List and Apply the Six Principal Views
  - A. Front view
  - B. Rear view
  - C. Right side view
  - D. Left side view
  - E. Top view
  - F. Bottom view
- VIII. List and Apply Auxiliary Views
  - A. Surfaces needing auxiliary views
    - 1. Inclined surfaces
    - 2. Oblique surfaces

- B. Primary auxiliary views
- C. Secondary auxiliary views
- D. To generate an auxiliary view
  1. Folding-line method
  2. Reference-plane method
- E. Classifications of auxiliary views
  1. Depth auxiliary views
  2. Height auxiliary views
  3. Width auxiliary views
- F. Dihedral angles
- G. Partial auxiliary views
- H. Half auxiliary views
- I. Auxiliary sections
- J. Basic four uses of auxiliary views
  1. True length of line
  2. Point view of line
  3. Edge view of plane
  4. True size of plane

IX. List and Apply Sectional Views

- A. Need for sectional views
- B. Cutting plane
  1. Direction
  2. Labels
  3. Alternate styles
- C. Section lining
  1. Techniques
  2. Symbols
- D. Types of sectional views
  1. Full section
  2. Half/partial section
  3. Broken-out section
  4. Revolved section
  5. Removed section
  6. Offset section
  7. Aligned section
  8. Auxiliary section
  9. Partial section

WELDER SERIES

MASTER Technical Module No. WLD-H07

SUBJECT: **WELDING TECHNICIAN** **TIME: 5 HOURS**

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Demonstrate Knowledge of Welding Symbols

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the basic elements if the A.W.S. Welding Symbol System;
B. Identify welding symbols for basic joints for weldment fabrication;
C. Use fillet weld in combination with other symbols;
D. Understand supplementary symbols and arrangements;
E. Understand plug and slot-weld symbols;
F. Understand spot weld and seam weld symbols;
G. Understand groove weld symbols;
H. Understand backing, back, melt through and surfacing symbols;
I. Understand flange and combination weld symbols; and,
J. Compare AWS symbols to international symbols.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Classroom handouts
MASTER Handout No. 1 (WLD-H7-HO1)
MASTER Handout No. 2 (WLD-H7-HO2)
MASTER Handout No. 3 (WLD-H7-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition
Standard Symbols for Welding, Brazing, and Nondestructive Examination, The American Welding Society, Standard A2-4, Miami, FL, Latest Edition
Welding Handbook, The American Welding Society, Miami, FL, Latest Edition
Symbolic Representation on Drawings, ISO 2553-1984, ANSI International Organization for Standardization, Standard Welds, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition

---

STUDENT PREPARATION:

The purpose of this program is to assist the student in the use of welding symbols that are part of the American Welding Society welding symbol system, and are accepted throughout the industry. A special study of these symbols must be made by the student in order to perform work at the professional level.

Students should have previously completed the following Technical Modules:
WLD-H6 "Understand and Interpret Shop Drawings for Precise Layout"

INTRODUCTION:

The Course Introduction will Include:

- The need for understanding of both AWS and ISO welding symbols
- A class demonstration of effective use of welding symbols to convey ideas and calculations to welders

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Present the basic elements if the A.W.S. Welding Symbol System
B. Present welding symbols for basic joints for weldment fabrication
C. Present fillet weld in combination with other symbols
D. Present supplementary symbols and arrangements
E. Present plug and slot-weld symbols
F. Present spot weld and seam weld symbols
G. Present groove weld symbols
H. Present backing, back, melt through and surfacing symbols
I. Present flange and combination weld symbols
J. Compare AWS symbols to international symbols

Student Activities:

A. Identify AWS symbols on drawings
B. Identify ISO symbols on drawings
C. Plan a job that includes symbols and specifications from AWS and ISO

PRACTICAL APPLICATION

This lesson will have relevance to the welder in day to day work planning, estimating and layout of the work.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

Welding technicians must become knowledgeable in the use of welding symbols, since they have become the language of the industry.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H8) dealing with identifying various structural shapes and their respective parts.

WLD-H7-HO1
Demonstrate Knowledge of Welding Symbols
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the basic elements if the A.W.S. Welding Symbol System;
B. Identify welding symbols for basic joints for weldment fabrication;
C. Use fillet weld in combination with other symbols;
D. Understand supplementary symbols and arrangements;
E. Understand plug and slot-weld symbols;
F. Understand spot weld and seam weld symbols;
G. Understand groove weld symbols;
H. Understand backing, back, melt through and surfacing symbols;
I. Understand flange and combination weld symbols; and,
J. Compare AWS symbols to international symbols.

MODULE OUTLINE:

Instructional Topics:

A. Present the basic elements if the A.W.S. Welding Symbol System
B. Present welding symbols for basic joints for weldment fabrication
C. Present fillet weld in combination with other symbols
D. Present supplementary symbols and arrangements
E. Present plug and slot-weld symbols
F. Present spot weld and seam weld symbols
G. Present groove weld symbols
H. Present backing, back, melt through and surfacing symbols
I. Present flange and combination weld symbols
J. Compare AWS symbols to international symbols

Student Activities:

A. Identify AWS symbols on drawings
B. Identify ISO symbols on drawings
C. Plan a job that includes symbols and specifications from AWS and ISO

WLD-H7-HO2
Demonstrate Knowledge of Welding Symbols
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning
        3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
  - 1. General tolerances
  - 2. Limit dimensioning
  - 3. Plus and minus dimensioning
    - a. Unilateral system
    - b. Bilateral system
  - 4. Single-limit dimensioning
  - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
  - 1. Clearance fit
  - 2. Interference fit
  - 3. Transition fit
  - 4. Line fit
- B. Limits and fits for cylindrical parts
  - 1. Running or sliding clearance fits
  - 2. Locational clearance fits
  - 3. Transition clearance interference fits
  - 4. Locational interference fits
  - 5. Force or shrink fits

WLD-H7-HO3
Demonstrate Knowledge of Welding Symbols
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry
III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols
    1. Straightness

        2. Flatness
        3. Circularity
        4. Cylindrical

IV. Explain and Use Profile Tolerances
    A. Explain profile tolerance
    B. Identify and use profile tolerance symbols
        1. Profile of a line
        2. Profile of a surface
        3. Profile of an arc
        4. Profile of irregular curves
        5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
    A. Explain orientation tolerances
    B. Identify and use orientation tolerance symbols
        1. Parallelism
        2. Perpendicularity
        3. Angularity

VI. Explain and Use Runout Tolerances
    A. Explain runouts
        1. Circular
        2. Total
    B. Identify and use runout tolerances symbols
        1. Circular
        2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    A. Maximum Material Condition (MMC)
    B. Regardless of Feature Size (RFS)
    C. Least Material Condition (LMC)
    D. Datum feature symbol
    E. Datum reference frame concept
        1. Primary datum plane
        2. Secondary datum plane
        3. Tertiary datum plane
    F. Datum target symbol
        1. Target point
        2. Target line
        3. Target area

VIII. Explain and Use the Feature Control Frame
    A. Explain feature control frame
    B. Explain the compartments of a feature control frame
        1. Geometric characteristic symbol
        2. Geometric tolerance
        3. Zone descriptor
        4. Material condition symbol
        5. Primary datum reference

        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WELDER SERIES
MASTER Technical Module No. WLD-H08

SUBJECT: WELDING TECHNICIAN **TIME:** 6 HOURS

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Identify Various Structural Shapes and Their Respective Parts

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand structural shapes; and,

B. Understand how to measure structural shapes.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Classroom handouts
MASTER Handout No. 1 (WLD-H8-HO1)
MASTER Handout No. 2 (WLD-H8-HO2)
MASTER Handout No. 3 (WLD-H8-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Standard Symbols for Welding, Brazing, and Nondestructive Examination, The American Welding Society, Standard A2-4, Miami, FL, Latest Edition
Welding Handbook, The American Welding Society, Miami, FL, Latest Edition
Symbolic Representation on Drawings, ISO 2553-1984, ANSI International Organization for Standardization, Standard Welds, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition

STUDENT PREPARATION:

The purpose of this module is to assist the student in identifying various structural shapes and their respective parts.

Students should have previously completed the following Technical Modules:
WLD-H7 "Demonstrate Knowledge of Welding Symbols"

INTRODUCTION:

The Course Introduction will Include:

- The importance of knowing the structural shapes available and how their sizes are specified
- A class demonstration of effective layout techniques with structural shapes and work planning
- The criticality of knowing how and where to measure structural shapes

PRESENTATION OUTLINE:

Instructional Topics:

A. Structural shapes frequently encountered by the welder
B. How sizes are specified
C. Measurement techniques for structural shapes
D. Use of gages for sheet steel, brass, aluminum, copper and others
E. Weight and size specifications for reinforcing members of the structure
F. Sizing of pipe
G. Structural beams classified as four shapes
H. Ordering structural metal

Student Activities:

A. Use of appropriate measurement techniques for structural shapes
B. Selection of gages for sheet metal
C. Ordering of materials

PRACTICAL APPLICATION:

This lesson will cover structural shapes, drawing symbols, and specifications. The students will have the opportunity to use precision measuring tools and prepare bills of materials to support drawing specifications.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The instructor will emphasize major considerations for dimensioning and tolerancing of structural shapes as they are planned as elements of the total welding requirements.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H9) dealing with identifying structural components and support frameworks of buildings and their components.

WLD-H8-HO1
Identify Various Structural Shapes and Their Respective Parts
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand structural shapes; and,
B. Understand how to measure structural shapes.

MODULE OUTLINE:

Instructional Topics:

A. Structural shapes frequently encountered by the welder
B. How sizes are specified
C. Measurement techniques for structural shapes
D. Use of gages for sheet steel, brass, aluminum, copper and others
E. Weight and size specifications for reinforcing members of the structure
F. Sizing of pipe
G. Structural beams classified as four shapes
H. Ordering structural metal

Student Activities:

A. Use of appropriate measurement techniques for structural shapes
B. Selection of gages for sheet metal
C. Ordering of materials

WLD-H8-HO2
Identify Various Structural Shapes and Their Respective Parts
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
   A. General notes
   B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
   A. General notes applied
      1. Title strip/title block
      2. Parts list/bill of material
   B. Interpret general notes
      1. Including material
      2. General tolerances
      3. Heat treatment
      4. Pattern information
      5. Processes of manufacture
      6. Requirements of the product
   C. Interpret specific notes
      1. Apply to specific operations
      2. Apply to specific processes of manufacture
      3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
   A. Identify organizations that determine dimension standards
      1. American National Standards Institutes (ANSI)
      2. International Standards Organization (ISO)
   B. Determine dimensions on a drawing
      1. Size dimensions
      2. Location dimensions
   C. Applying dimensions on a drawing
      1. Scale of drawing
      2. Techniques of dimensioning
      3. Placement of dimensions

4. Choice of dimensions
5. Types of lines used in the dimensioning process
6. Arrowheads used on drawings
7. Leaders used on drawings
8. Dimensioning systems
    a. Fractional
    b. Decimal
    c. Metric
    d. Combination dimensioning
9. Dimension figures
10. Direction of dimension figures
    a. Unidirectional system
    b. Aligned system
11. Dimensioning angles
12. Dimensioning arcs
13. Dimensioning fillets and rounds
14. Identify surfaces to be machined
15. Contour dimensioning
16. Dimensioning of curves
17. Dimensioning of rounded-end shapes
18. Dimensioning of threads
19. Dimensioning of tapers
20. Dimensioning of chamfers
21. Dimensioning shaft centers
22. Dimensioning keyways
23. Dimensioning knurls
    a. Diamond
    b. Straight
24. Dimensioning along curved surfaces
25. Tabular dimensions
26. Dimensioning standards
27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

B. Methods of expressing tolerances
    1. General tolerances
    2. Limit dimensioning
    3. Plus and minus dimensioning
        a. Unilateral system
        b. Bilateral system
    4. Single-limit dimensioning
    5. Angular tolerances

VI. Identify ANSI Limits and Fits
    A. Fits between mating parts
        1. Clearance fit
        2. Interference fit
        3. Transition fit
        4. Line fit
    B. Limits and fits for cylindrical parts
        1. Running or sliding clearance fits
        2. Locational clearance fits
        3. Transition clearance interference fits
        4. Locational interference fits
        5. Force or shrink fits

WLD-H8-HO3
Identify Various Structural Shapes and Their Respective Parts
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry
III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols
    1. Straightness

        2. Flatness
        3. Circularity
        4. Cylindrical

IV. Explain and Use Profile Tolerances
    A. Explain profile tolerance
    B. Identify and use profile tolerance symbols
        1. Profile of a line
        2. Profile of a surface
        3. Profile of an arc
        4. Profile of irregular curves
        5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
    A. Explain orientation tolerances
    B. Identify and use orientation tolerance symbols
        1. Parallelism
        2. Perpendicularity
        3. Angularity

VI. Explain and Use Runout Tolerances
    A. Explain runouts
        1. Circular
        2. Total
    B. Identify and use runout tolerances symbols
        1. Circular
        2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    A. Maximum Material Condition (MMC)
    B. Regardless of Feature Size (RFS)
    C. Least Material Condition (LMC)
    D. Datum feature symbol
    E. Datum reference frame concept
        1. Primary datum plane
        2. Secondary datum plane
        3. Tertiary datum plane
    F. Datum target symbol
        1. Target point
        2. Target line
        3. Target area

VIII. Explain and Use the Feature Control Frame
    A. Explain feature control frame
    B. Explain the compartments of a feature control frame
        1. Geometric characteristic symbol
        2. Geometric tolerance
        3. Zone descriptor
        4. Material condition symbol
        5. Primary datum reference

        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WELDER SERIES

MASTER Technical Module No. WLD-H09

SUBJECT: **WELDING TECHNICIAN** **TIME: 5 HOURS**

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Identify Structural Components and Support Frameworks of Buildings and Their Components

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand metal structures and foundation of buildings

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Classroom handouts
MASTER Handout No. 1 (WLD-H9-HO1)
MASTER Handout No. 2 (WLD-H9-HO2)
MASTER Handout No. 3 (WLD-H9-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Standard Symbols for Welding, Brazing, and Nondestructive Examination, The American Welding Society, Standard A2-4, Miami, FL, Latest Edition
Welding Handbook, The American Welding Society, Miami, FL, Latest Edition
Symbolic Representation on Drawings, ISO 2553-1984, ANSI International Organization for Standardization, Standard Welds, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition

STUDENT PREPARATION:

The purpose of this module is to assist the student in the preparation of cutting and welding of metal beams as used in building construction.

Students should have previously completed the following Technical Modules:

WLD-H8 "Identify Various Structural Shapes and Their Respective Parts"

INTRODUCTION:

The Module Introduction will Include:

- The wide variety of work that may be performed by welders in different occupational fields
- A demonstration of the application of metal structures in building construction

PRESENTATION OUTLINE:

Instructional Topics:

A. Discuss the types of metal beams used in building construction
B. Discuss the types of metal piping used in building and fluid distribution systems
C. Discuss methods of construction that require welding skills

Student Activities:

A. Visit a construction site where metal beams and piping are being installed
B. Demonstrate cutting or welding of metal components used in construction

PRACTICAL APPLICATION:

This lesson will cover the general use of metals and weldments in construction. The students will have the opportunity to review these applications at the work site.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The instructor will emphasize the variety of work applications available to the welder, with major consideration again for planning and safety in all welding activities.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H10) dealing with describing proper placement of stiffeners and supports when modifying existing structures.

WLD-H9-HO1
Identify Structural Components and Support Frameworks of Buildings and Their Components
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand metal structures and foundation of buildings

---

MODULE OUTLINE:

Instructional Topics:

A. Discuss the types of metal beams used in building construction
B. Discuss the types of metal piping used in building and fluid distribution systems
C. Discuss methods of construction that require welding skills

Student Activities:

A. Visit a construction site where metal beams and piping are being installed
B. Demonstrate cutting or welding of metal components used in construction

WLD-H9-HO2
Identify Structural Components and Support Frameworks
of Buildings and Their Components
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning

    3. Placement of dimensions
    4. Choice of dimensions
    5. Types of lines used in the dimensioning process
    6. Arrowheads used on drawings
    7. Leaders used on drawings
    8. Dimensioning systems
        a. Fractional
        b. Decimal
        c. Metric
        d. Combination dimensioning
    9. Dimension figures
    10. Direction of dimension figures
        a. Unidirectional system
        b. Aligned system
    11. Dimensioning angles
    12. Dimensioning arcs
    13. Dimensioning fillets and rounds
    14. Identify surfaces to be machined
    15. Contour dimensioning
    16. Dimensioning of curves
    17. Dimensioning of rounded-end shapes
    18. Dimensioning of threads
    19. Dimensioning of tapers
    20. Dimensioning of chamfers
    21. Dimensioning shaft centers
    22. Dimensioning keyways
    23. Dimensioning knurls
        a. Diamond
        b. Straight
    24. Dimensioning along curved surfaces
    25. Tabular dimensions
    26. Dimensioning standards
    27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
  A. Traditional terms used to describe various shapes, processes, and sizes
  B. Identify abbreviations used to describe various shapes, processes, and size
  C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
  A. Identify tolerances or limits
    1. Nominal size
    2. Basic size or dimension
    3. Actual size
    4. Tolerance
    5. Limits

        6. Allowance
    B. Methods of expressing tolerances
        1. General tolerances
        2. Limit dimensioning
        3. Plus and minus dimensioning
            a. Unilateral system
            b. Bilateral system
        4. Single-limit dimensioning
        5. Angular tolerances

VI. Identify ANSI Limits and Fits
    A. Fits between mating parts
        1. Clearance fit
        2. Interference fit
        3. Transition fit
        4. Line fit
    B. Limits and fits for cylindrical parts
        1. Running or sliding clearance fits
        2. Locational clearance fits
        3. Transition clearance interference fits
        4. Locational interference fits
        5. Force or shrink fits

WLD-H9-HO3
Identify Structural Components and Support Frameworks of Buildings and Their Components
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
    A. General/conventional tolerancing
        1. Definitions of general/conventional tolerancing
            a. Dimension
            b. Reference dimension
            c. Feature
            d. Feature of size
            e. Actual size
            f. Stock size
        2. Maximum material condition
        3. Least material condition
        4. Basic fits
        5. Clearance fit
        6. Allowance
        7. Clearance
        8. Force fit
    B. Geometric dimensioning and tolerancing
        1. Definition of geometric dimensioning and tolerancing
        2. Dimensioning rules
        3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
    A. Explain positional / location tolerances
    B. Identify and use geometric position tolerancing symbols
        1. Position
        2. Concentricity
        3. Symmetry
III. Explain and Use Tolerances of Form Symbols
    A. Explain form tolerances
    B. Identify and use tolerances of form symbols

1. Straightness
2. Flatness
3. Circularity
4. Cylindrical

IV. Explain and Use Profile Tolerances
  A. Explain profile tolerance
  B. Identify and use profile tolerance symbols
    1. Profile of a line
    2. Profile of a surface
    3. Profile of an arc
    4. Profile of irregular curves
    5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
  A. Explain orientation tolerances
  B. Identify and use orientation tolerance symbols
    1. Parallelism
    2. Perpendicularity
    3. Angularity

VI. Explain and Use Runout Tolerances
  A. Explain runouts
    1. Circular
    2. Total
  B. Identify and use runout tolerances symbols
    1. Circular
    2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  A. Maximum Material Condition (MMC)
  B. Regardless of Feature Size (RFS)
  C. Least Material Condition (LMC)
  D. Datum feature symbol
  E. Datum reference frame concept
    1. Primary datum plane
    2. Secondary datum plane
    3. Tertiary datum plane
  F. Datum target symbol
    1. Target point
    2. Target line
    3. Target area

VIII. Explain and Use the Feature Control Frame
  A. Explain feature control frame
  B. Explain the compartments of a feature control frame
    1. Geometric characteristic symbol
    2. Geometric tolerance
    3. Zone descriptor
    4. Material condition symbol

5. Primary datum reference
6. Secondary datum reference
7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

A. Explain and use additional modifying symbols.

1. Diameter
2. Radius R
3. Reference ( )
4. Counterbore/spotface L/
5. Square
6. Dimension origin O
7. Slope
8. Projected tolerance zone
9. Spherical diameter
10. Spherical radius
11. Arc length
12. Counter sink
13. Depth
14. Conical taper
15. Place, times, or by
16. Basic dimension

WELDER SERIES

MASTER Technical Module No. WLD-H10

SUBJECT: WELDING TECHNICIAN TIME: 4 HOURS

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Describe Proper Placement of Stiffeners and Supports When Modifying Existing Structures

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand gussets and cross members for support of structures

---

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Classroom handouts
MASTER Handout No. 1 (WLD-H10-HO1)
MASTER Handout No. 2 (WLD-H10-HO2)
MASTER Handout No. 3 (WLD-H10-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Standard Symbols for Welding, Brazing, and Nondestructive Examination, The American Welding Society, Standard A2-4, Miami, FL, Latest Edition
Welding Handbook, The American Welding Society, Miami, FL, Latest Edition
Symbolic Representation on Drawings, ISO 2553-1984, ANSI International Organization for Standardization, Standard Welds, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition

STUDENT PREPARATION:

The purpose of this module is to assist the student in the layout and use of metal supports in modifying existing structures.

Students should have previously completed the following Technical Modules:

WLD-H9 "Identify Structural Components and Support Frameworks of Buildings and Their Components"

INTRODUCTION:

The Course Introduction will Include:

- An overview of the strength characteristics of various metals
- A class demonstration of effective use of welded supports in structures
- A discussion on methods leading to an increase of skill and knowledge in order to be diversified, and a more valuable employee

PRESENTATION OUTLINE:

Instructional Topics:

A. Use of welded supports in structures
B. Selection of metal support members
C. Types of welds for supports
D. Verification of quality in welds
E. Codes and standards for supporting structures

Student Activities:

A. Visit a construction site where this work is done
B. Visit a metals manufacturer where design work is performed

PRACTICAL APPLICATION:

This module will assist the student in planning work in placement of metal stiffeners and supports.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The instructor will emphasize the importance of following engineering drawings, codes, and specifications for this work. The welder will benefit by understanding the planning, placement and the welding operations that follow.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H11) dealing with identifying fillet weld sizes for various thicknesses of base metals.

WLD-H10-HO1
Describe Proper Placement of Stiffeners and Supports When Modifying Existing Structures
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand gussets and cross members for support of structures

---

MODULE OUTLINE:

Instructional Topics:

A. Use of welded supports in structures
B. Selection of metal support members
C. Types of welds for supports
D. Verification of quality in welds
E. Codes and standards for supporting structures

Student Activities:

A. Visit a construction site where this work is done
B. Visit a metals manufacturer where design work is performed

WLD-H10-HO2
Describe Proper Placement of Stiffeners and Supports When Modifying Existing Structures
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Distinguish between general and specific notes;
- b. Interpret and apply general and specific notes;
- c. Determine and apply dimensions on a drawing;
- d. Identify basic symbols and abbreviations found on a drawing;
- e. Identify tolerances or limits on a drawing; and,
- f. Identify ANSI limits and fits.

MODULE OUTLINE:

- I. Distinguish Between General and Specific Notes
  - A. General notes
  - B. Specific notes/local notes
- II. Interpret and Apply General and Specific Notes
  - A. General notes applied
    - 1. Title strip/title block
    - 2. Parts list/bill of material
  - B. Interpret general notes
    - 1. Including material
    - 2. General tolerances
    - 3. Heat treatment
    - 4. Pattern information
    - 5. Processes of manufacture
    - 6. Requirements of the product
  - C. Interpret specific notes
    - 1. Apply to specific operations
    - 2. Apply to specific processes of manufacture
    - 3. Apply to the requirements of the product
- III. Determine and Apply Dimensions on a Drawing
  - A. Identify organizations that determine dimension standards
    - 1. American National Standards Institutes (ANSI)
    - 2. International Standards Organization (ISO)
  - B. Determine dimensions on a drawing
    - 1. Size dimensions
    - 2. Location dimensions
  - C. Applying dimensions on a drawing
    - 1. Scale of drawing
    - 2. Techniques of dimensioning

        3. Placement of dimensions
        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits

        6. Allowance
    B. Methods of expressing tolerances
        1. General tolerances
        2. Limit dimensioning
        3. Plus and minus dimensioning
            a. Unilateral system
            b. Bilateral system
        4. Single-limit dimensioning
        5. Angular tolerances

VI. Identify ANSI Limits and Fits
    A. Fits between mating parts
        1. Clearance fit
        2. Interference fit
        3. Transition fit
        4. Line fit
    B. Limits and fits for cylindrical parts
        1. Running or sliding clearance fits
        2. Locational clearance fits
        3. Transition clearance interference fits
        4. Locational interference fits
        5. Force or shrink fits

WLD-H10-HO3
Describe Proper Placement of Stiffeners and Supports When Modifying Existing Structures
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units

II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry

III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols

- 1. Straightness
- 2. Flatness
- 3. Circularity
- 4. Cylindrical

- IV. Explain and Use Profile Tolerances
  - A. Explain profile tolerance
  - B. Identify and use profile tolerance symbols
    - 1. Profile of a line
    - 2. Profile of a surface
    - 3. Profile of an arc
    - 4. Profile of irregular curves
    - 5. Profile of coplanar surfaces
- V. Explain and Use Tolerances of Orientation
  - A. Explain orientation tolerances
  - B. Identify and use orientation tolerance symbols
    - 1. Parallelism
    - 2. Perpendicularity
    - 3. Angularity
- VI. Explain and Use Runout Tolerances
  - A. Explain runouts
    - 1. Circular
    - 2. Total
  - B. Identify and use runout tolerances symbols
    - 1. Circular
    - 2. Total
- VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  - A. Maximum Material Condition (MMC)
  - B. Regardless of Feature Size (RFS)
  - C. Least Material Condition (LMC)
  - D. Datum feature symbol
  - E. Datum reference frame concept
    - 1. Primary datum plane
    - 2. Secondary datum plane
    - 3. Tertiary datum plane
  - F. Datum target symbol
    - 1. Target point
    - 2. Target line
    - 3. Target area
- VIII. Explain and Use the Feature Control Frame
  - A. Explain feature control frame
  - B. Explain the compartments of a feature control frame
    - 1. Geometric characteristic symbol
    - 2. Geometric tolerance
    - 3. Zone descriptor
    - 4. Material condition symbol

        5. Primary datum reference
        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WELDER SERIES

MASTER Technical Module No. WLD-H11

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Identify Fillet Weld Sizes for Various Thicknesses of Base Metals

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand blue print requirements for welds; and,
B. Understand weld size gauges.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Classroom handouts
MASTER Handout No. 1 (WLD-H11-HO1)
MASTER Handout No. 2 (WLD-H11-HO2)
MASTER Handout No. 3 (WLD-H11-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Standard Symbols for Welding, Brazing, and Nondestructive Examination, The American Welding Society, Standard A2-4, Miami, FL, Latest Edition
Welding Handbook, The American Welding Society, Miami, FL, Latest Edition
Symbolic Representation on Drawings, ISO 2553-1984, ANSI International Organization for Standardization, Standard Welds, Latest Edition

Welding Technology Today, Principles and Practices, Stinchcomb, Craig,
New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition

---

STUDENT PREPARATION:

The purpose of this module is to assist the student in one of the most widely used type of welds.

Students should have previously completed the following Technical Modules:

WLD-H10 "Describe Proper Placement of Stiffeners and Supports When Modifying Existing Structures"

INTRODUCTION:

The Module Introduction will Include:

- An overview of fillet weld applications
- The importance of sizing pitch, contours, and finishing of base metals
- A discussion on methods leading to an increase of skill and knowledge in order to be diversified, and a more valuable employee
- The use of appropriate symbols to convey concepts and specifications

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Selection of the base metals
B. Sizing of the weld
C. Use of gages
D. Length of weld and extent of welding
E. Pitch, contour, and finishing

Student Activities:

A. Practice use of symbols for fillet welds
B. Interpret specifications and plan work from a drawing with fillet welds

---

PRACTICAL APPLICATION:

This module will cover the symbols and drawing specifications for fillet welds.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The instructor will emphasize variety and scope of fillet welds that are specified for the welder. Sizing for various thicknesses of base metals was emphasized. Welding symbols were reviewed and the students were provided with a copy of AWS weld symbols.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H12) dealing with describing proper sequence when cutting various shapes to structural drawing specs.

WLD-H11-HO1

Identify Fillet Weld Sizes for Various Thicknesses of Base Metals

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand blue print requirements for welds; and,

B. Understand weld size gauges.

MODULE OUTLINE:

Instructional Topics:

A. Selection of the base metals

B. Sizing of the weld

C. Use of gages

D. Length of weld and extent of welding

E. Pitch, contour, and finishing

Student Activities:

A. Practice use of symbols for fillet welds

B. Interpret specifications and plan work from a drawing with fillet welds

WLD-H11-HO2
Identify Fillet Weld Sizes for Various Thicknesses of Base Metals
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- a. Distinguish between general and specific notes;
- b. Interpret and apply general and specific notes;
- c. Determine and apply dimensions on a drawing;
- d. Identify basic symbols and abbreviations found on a drawing;
- e. Identify tolerances or limits on a drawing; and,
- f. Identify ANSI limits and fits.

MODULE OUTLINE:

- I. Distinguish Between General and Specific Notes
  - A. General notes
  - B. Specific notes/local notes
- II. Interpret and Apply General and Specific Notes
  - A. General notes applied
    - 1. Title strip/title block
    - 2. Parts list/bill of material
  - B. Interpret general notes
    - 1. Including material
    - 2. General tolerances
    - 3. Heat treatment
    - 4. Pattern information
    - 5. Processes of manufacture
    - 6. Requirements of the product
  - C. Interpret specific notes
    - 1. Apply to specific operations
    - 2. Apply to specific processes of manufacture
    - 3. Apply to the requirements of the product
- III. Determine and Apply Dimensions on a Drawing
  - A. Identify organizations that determine dimension standards
    - 1. American National Standards Institutes (ANSI)
    - 2. International Standards Organization (ISO)
  - B. Determine dimensions on a drawing
    - 1. Size dimensions
    - 2. Location dimensions
  - C. Applying dimensions on a drawing
    - 1. Scale of drawing
    - 2. Techniques of dimensioning
    - 3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
    - 1. General tolerances
    - 2. Limit dimensioning
    - 3. Plus and minus dimensioning
        - a. Unilateral system
        - b. Bilateral system
    - 4. Single-limit dimensioning
    - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
    - 1. Clearance fit
    - 2. Interference fit
    - 3. Transition fit
    - 4. Line fit
- B. Limits and fits for cylindrical parts
    - 1. Running or sliding clearance fits
    - 2. Locational clearance fits
    - 3. Transition clearance interference fits
    - 4. Locational interference fits
    - 5. Force or shrink fits

WLD-H11-HO3
Identify Fillet Weld Sizes for Various Thicknesses of Base Metals
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry
III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols

1. Straightness
2. Flatness
3. Circularity
4. Cylindrical

IV. Explain and Use Profile Tolerances
   A. Explain profile tolerance
   B. Identify and use profile tolerance symbols
      1. Profile of a line
      2. Profile of a surface
      3. Profile of an arc
      4. Profile of irregular curves
      5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
   A. Explain orientation tolerances
   B. Identify and use orientation tolerance symbols
      1. Parallelism
      2. Perpendicularity
      3. Angularity

VI. Explain and Use Runout Tolerances
   A. Explain runouts
      1. Circular
      2. Total
   B. Identify and use runout tolerances symbols
      1. Circular
      2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
   A. Maximum Material Condition (MMC)
   B. Regardless of Feature Size (RFS)
   C. Least Material Condition (LMC)
   D. Datum feature symbol
   E. Datum reference frame concept
      1. Primary datum plane
      2. Secondary datum plane
      3. Tertiary datum plane
   F. Datum target symbol
      1. Target point
      2. Target line
      3. Target area

VIII. Explain and Use the Feature Control Frame
   A. Explain feature control frame
   B. Explain the compartments of a feature control frame
      1. Geometric characteristic symbol
      2. Geometric tolerance
      3. Zone descriptor
      4. Material condition symbol

        5. Primary datum reference
        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WELDER SERIES

MASTER Technical Module No. WLD-H12

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Describe Proper Sequence When Cutting Various Shapes to Structural Drawing Specs

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand removal of components to specifications; AND,
B. Understand replacement of components to specification.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Classroom handouts
MASTER Handout No. 1 (WLD-H12-HO1)
MASTER Handout No. 2 (WLD-H12-HO2)
MASTER Handout No. 3 (WLD-H12-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Standard Symbols for Welding, Brazing, and Nondestructive Examination, The American Welding Society, Standard A2-4, Miami, FL, Latest Edition
Welding Handbook, The American Welding Society, Miami, FL, Latest Edition
Symbolic Representation on Drawings, ISO 2553-1984, ANSI International Organization for Standardization, Standard Welds, Latest Edition

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition

---

STUDENT PREPARATION:

The purpose of this module is to assist the student in understanding the proper cutting sequence when cutting various structural shapes.

Students should have previously completed the following Technical Modules:

WLD-H11 "Identify Fillet Weld Sizes for Various Thicknesses of Base Metals"

INTRODUCTION:

The Module Introduction will Include:

- The importance of cutting metal to specification with the proper shape required by specification
- A class demonstration of effective cutting sequence for specifications
- A discussion on methods leading to an increase of skill and knowledge in order to be diversified, and a more valuable employee

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Preparation of the base material
B. Grinding and heat treating required
C. Surfaces and edges to be welded (surface roughness)
D. How to avoid cutting beyond prescribed lines
E. Inspection and repair of cut edges
F. Limits of acceptability and repair of discontinuities
G. Control of distortion and shrinkage

Student Activities:

A. Practice cutting to specification
B. Examine quality of finished part

PRACTICAL APPLICATION:

This lesson will cover where to look for a specific measurement on a blueprint and how to determine tolerance from the information given on a blueprint.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The instructor emphasizes proper cutting preparation and sequence, and the visual inspection and repair of cut edges. Welding symbols were reviewed.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H13) dealing with describing methods for layout slopes and rolling tolerances.

WLD-H12-HO1
Describe Proper Sequence When Cutting Various Shapes To Structural Drawing Specs
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand removal of components to specifications; AND,
B. Understand replacement of components to specification.

MODULE OUTLINE:

Instructional Topics:

A. Preparation of the base material
B. Grinding and heat treating required
C. Surfaces and edges to be welded (surface roughness)
D. How to avoid cutting beyond prescribed lines
E. Inspection and repair of cut edges
F. Limits of acceptability and repair of discontinuities
G. Control of distortion and shrinkage

Student Activities:

A. Practice cutting to specification
B. Examine quality of finished part

WLD-H12-HO2
Describe Proper Sequence When Cutting Various Shapes To Structural Drawing Specs
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning

        3. Placement of dimensions
        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits

        6. Allowance
    B. Methods of expressing tolerances
        1. General tolerances
        2. Limit dimensioning
        3. Plus and minus dimensioning
            a. Unilateral system
            b. Bilateral system
        4. Single-limit dimensioning
        5. Angular tolerances
VI. Identify ANSI Limits and Fits
    A. Fits between mating parts
        1. Clearance fit
        2. Interference fit
        3. Transition fit
        4. Line fit
    B. Limits and fits for cylindrical parts
        1. Running or sliding clearance fits
        2. Locational clearance fits
        3. Transition clearance interference fits
        4. Locational interference fits
        5. Force or shrink fits

WLD-H12-HO3
Describe Proper Sequence When Cutting Various Shapes To Structural Drawing Specs
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
    A. General/conventional tolerancing
        1. Definitions of general/conventional tolerancing
            a. Dimension
            b. Reference dimension
            c. Feature
            d. Feature of size
            e. Actual size
            f. Stock size
        2. Maximum material condition
        3. Least material condition
        4. Basic fits
        5. Clearance fit
        6. Allowance
        7. Clearance
        8. Force fit
    B. Geometric dimensioning and tolerancing
        1. Definition of geometric dimensioning and tolerancing
        2. Dimensioning rules
        3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
    A. Explain positional / location tolerances
    B. Identify and use geometric position tolerancing symbols
        1. Position
        2. Concentricity
        3. Symmetry
III. Explain and Use Tolerances of Form Symbols
    A. Explain form tolerances

B. Identify and use tolerances of form symbols
  1. Straightness
  2. Flatness
  3. Circularity
  4. Cylindrical

IV. Explain and Use Profile Tolerances
  A. Explain profile tolerance
  B. Identify and use profile tolerance symbols
    1. Profile of a line
    2. Profile of a surface
    3. Profile of an arc
    4. Profile of irregular curves
    5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
  A. Explain orientation tolerances
  B. Identify and use orientation tolerance symbols
    1. Parallelism
    2. Perpendicularity
    3. Angularity

VI. Explain and Use Runout Tolerances
  A. Explain runouts
    1. Circular
    2. Total
  B. Identify and use runout tolerances symbols
    1. Circular
    2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  A. Maximum Material Condition (MMC)
  B. Regardless of Feature Size (RFS)
  C. Least Material Condition (LMC)
  D. Datum feature symbol
  E. Datum reference frame concept
    1. Primary datum plane
    2. Secondary datum plane
    3. Tertiary datum plane
  F. Datum target symbol
    1. Target point
    2. Target line
    3. Target area

VIII. Explain and Use the Feature Control Frame
  A. Explain feature control frame
  B. Explain the compartments of a feature control frame
    1. Geometric characteristic symbol
    2. Geometric tolerance
    3. Zone descriptor

    4. Material condition symbol
    5. Primary datum reference
    6. Secondary datum reference
    7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

  A. Explain and use additional modifying symbols.
    1. Diameter
    2. Radius R
    3. Reference ( )
    4. Counterbore/spotface L/
    5. Square
    6. Dimension origin O
    7. Slope
    8. Projected tolerance zone
    9. Spherical diameter
    10. Spherical radius
    11. Arc length
    12. Counter sink
    13. Depth
    14. Conical taper
    15. Place, times, or by
    16. Basic dimension

WELDER SERIES

MASTER Technical Module No. WLD-H13

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Describe Methods for Layout Slopes and Rolling Tolerances

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the references of a blueprint and drawing; and,

B. Understand precision, reliability, accuracy.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Classroom handouts
MASTER Handout No. 1 (WLD-H13-HO1)
MASTER Handout No. 2 (WLD-H13-HO2)
MASTER Handout No. 3 (WLD-H13-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Standard Symbols for Welding, Brazing, and Nondestructive Examination, The American Welding Society, Standard A2-4, Miami, FL, Latest Edition
Welding Handbook, The American Welding Society, Miami, FL, Latest Edition
Symbolic Representation on Drawings, ISO 2553-1984, ANSI International Organization for Standardization, Standard Welds, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition

---

STUDENT PREPARATION:

The purpose of this module is to assist the student in the use of slope, dimensions, and tolerances.

Students should have previously completed the following Technical Modules:

WLD-H12 "Describe Proper Sequence When Cutting Various Shapes to Structural Drawing Specs"

INTRODUCTION:

The Module Introduction will Include:

- An overview of drawing references and tolerances.

PRESENTATION OUTLINE:

Instructional Topics:

A. Demonstrate how to use the reference on a blueprint
B. Define precision, reliability and accuracy
C. Define tolerance and how to find it on a blueprint
D. Demonstrate semi-precision measurement techniques
E. Discuss the importance of the tolerance
F. Discriminate between accepted measurement procedures and improper measurement procedures

Student Activities:

A. Use measuring techniques on parts
B. Produce a drawing which includes weld symbols

PRACTICAL APPLICATION:

This module will cover where to look for a specific measurement on a blueprint and how to determine tolerance from the information given on a blueprint.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The instructor explained the benefit of using precise layout for production and quality. The effective use of slopes and tolerances was emphasized.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H14) dealing with describing the use of jigs and fixtures in layout and fit-up.

WLD-H13-HO1
Describe Methods for Layout Slopes and Rolling Tolerances
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the references of a blueprint and drawing; and,
B. Understand precision, reliability, accuracy.

MODULE OUTLINE:

Instructional Topics:

A. Demonstrate how to use the reference on a blueprint
B. Define precision, reliability and accuracy
C. Define tolerance and how to find it on a blueprint
D. Demonstrate semi-precision measurement techniques
E. Discuss the importance of the tolerance
F. Discriminate between accepted measurement procedures and improper measurement procedures

Student Activities:

A. Use measuring techniques on parts
B. Produce a drawing which includes weld symbols

WLD-H13-HO2
Describe Methods for Layout Slopes and Rolling Tolerances
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- a. Distinguish between general and specific notes;
- b. Interpret and apply general and specific notes;
- c. Determine and apply dimensions on a drawing;
- d. Identify basic symbols and abbreviations found on a drawing;
- e. Identify tolerances or limits on a drawing; and,
- f. Identify ANSI limits and fits.

MODULE OUTLINE:

- I. Distinguish Between General and Specific Notes
  - A. General notes
  - B. Specific notes/local notes
- II. Interpret and Apply General and Specific Notes
  - A. General notes applied
    - 1. Title strip/title block
    - 2. Parts list/bill of material
  - B. Interpret general notes
    - 1. Including material
    - 2. General tolerances
    - 3. Heat treatment
    - 4. Pattern information
    - 5. Processes of manufacture
    - 6. Requirements of the product
  - C. Interpret specific notes
    - 1. Apply to specific operations
    - 2. Apply to specific processes of manufacture
    - 3. Apply to the requirements of the product
- III. Determine and Apply Dimensions on a Drawing
  - A. Identify organizations that determine dimension standards
    - 1. American National Standards Institutes (ANSI)
    - 2. International Standards Organization (ISO)
  - B. Determine dimensions on a drawing
    - 1. Size dimensions
    - 2. Location dimensions
  - C. Applying dimensions on a drawing
    - 1. Scale of drawing
    - 2. Techniques of dimensioning
    - 3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

B. Methods of expressing tolerances
   1. General tolerances
   2. Limit dimensioning
   3. Plus and minus dimensioning
      a. Unilateral system
      b. Bilateral system
   4. Single-limit dimensioning
   5. Angular tolerances

VI. Identify ANSI Limits and Fits
   A. Fits between mating parts
      1. Clearance fit
      2. Interference fit
      3. Transition fit
      4. Line fit
   B. Limits and fits for cylindrical parts
      1. Running or sliding clearance fits
      2. Locational clearance fits
      3. Transition clearance interference fits
      4. Locational interference fits
      5. Force or shrink fits

WLD-H13-HO3
Describe Methods for Layout Slopes and Rolling Tolerances
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- a. Distinguish between conventional and geometric dimensioning and tolerancing;
- b. Explain and use geometric positional tolerancing and symbols;
- c. Explain and use tolerances of form and symbols;
- d. Explain and use the feature control symbol; and,
- e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

- I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  - A. General/conventional tolerancing
    - 1. Definitions of general/conventional tolerancing
      - a. Dimension
      - b. Reference dimension
      - c. Feature
      - d. Feature of size
      - e. Actual size
      - f. Stock size
    - 2. Maximum material condition
    - 3. Least material condition
    - 4. Basic fits
    - 5. Clearance fit
    - 6. Allowance
    - 7. Clearance
    - 8. Force fit
  - B. Geometric dimensioning and tolerancing
    - 1. Definition of geometric dimensioning and tolerancing
    - 2. Dimensioning rules
    - 3. Dimensioning units
- II. Explain and Use Geometric Positional Tolerancing and Symbols
  - A. Explain positional / location tolerances
  - B. Identify and use geometric position tolerancing symbols
    - 1. Position
    - 2. Concentricity
    - 3. Symmetry
- III. Explain and Use Tolerances of Form Symbols
  - A. Explain form tolerances
  - B. Identify and use tolerances of form symbols

      1. Straightness
      2. Flatness
      3. Circularity
      4. Cylindrical

IV. Explain and Use Profile Tolerances
   A. Explain profile tolerance
   B. Identify and use profile tolerance symbols
      1. Profile of a line
      2. Profile of a surface
      3. Profile of an arc
      4. Profile of irregular curves
      5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
   A. Explain orientation tolerances
   B. Identify and use orientation tolerance symbols
      1. Parallelism
      2. Perpendicularity
      3. Angularity

VI. Explain and Use Runout Tolerances
   A. Explain runouts
      1. Circular
      2. Total
   B. Identify and use runout tolerances symbols
      1. Circular
      2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
   A. Maximum Material Condition (MMC)
   B. Regardless of Feature Size (RFS)
   C. Least Material Condition (LMC)
   D. Datum feature symbol
   E. Datum reference frame concept
      1. Primary datum plane
      2. Secondary datum plane
      3. Tertiary datum plane
   F. Datum target symbol
      1. Target point
      2. Target line
      3. Target area

VIII. Explain and Use the Feature Control Frame
   A. Explain feature control frame
   B. Explain the compartments of a feature control frame
      1. Geometric characteristic symbol
      2. Geometric tolerance
      3. Zone descriptor
      4. Material condition symbol

        5. Primary datum reference
        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

- A. Explain and use additional modifying symbols.
    - 1. Diameter
    - 2. Radius R
    - 3. Reference ( )
    - 4. Counterbore/spotface L/
    - 5. Square
    - 6. Dimension origin O
    - 7. Slope
    - 8. Projected tolerance zone
    - 9. Spherical diameter
    - 10. Spherical radius
    - 11. Arc length
    - 12. Counter sink
    - 13. Depth
    - 14. Conical taper
    - 15. Place, times, or by
    - 16. Basic dimension

WELDER SERIES

MASTER Technical Module No. WLD-H14

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** Describe the Use of Jigs and Fixtures in Layout and Fit-Up

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand the use of fixtures and jigs for assembly and accuracy.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Classroom handout
MASTER Handout No. 1 (WLD-H14-HO1)
MASTER Handout No. 2 (WLD-H14-HO2)
MASTER Handout No. 3 (WLD-H14-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Standard Symbols for Welding, Brazing, and Nondestructive Examination, The American Welding Society, Standard A2-4, Miami, FL, Latest Edition
Welding Handbook, The American Welding Society, Miami, FL, Latest Edition
Symbolic Representation on Drawings, ISO 2553-1984, ANSI International Organization for Standardization, Standard Welds, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition

---

STUDENT PREPARATION:

The purpose of this module is to assist the student in the planning of work with the use of jigs and fixtures.

Students should have previously completed the following Technical Modules:

WLD-H13 "Describe Methods for Layout Slopes and Rolling Tolerances"

INTRODUCTION:

The Module Introduction will Include:

- A class demonstration of effective use of jigs and fixtures
- A discussion on methods that will insure correct alignment of parts or components

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup
B. Use of clamps and holding devices for correct alignment
C. Placement of tack welds

Student Activities:

A. Use clamps and holding devices to properly align parts to be welded
B. Weld or prepare a fixture for production welding

PRACTICAL APPLICATION:

This module describes the essential purpose and practicality of jigs and fixtures.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

Members to be welded shall be brought into correct alignment and held in position by fixtures, clamps, or by torch welds until the welding has been completed.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H15) dealing with listing the steps to be followed when planning a job.

WLD-H14-HO1

Describe the Use of Jigs and Fixtures in Layout and Fit-Up

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand the use of fixtures and jigs for assembly and accuracy.

MODULE OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup
B. Use of clamps and holding devices for correct alignment
C. Placement of tack welds

Student Activities:

A. Use clamps and holding devices to properly align parts to be welded
B. Weld or prepare a fixture for production welding

WLD-H14-HO2

Describe the Use of Jigs and Fixtures in Layout and Fit-Up

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
  A. General notes
  B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
  A. General notes applied
    1. Title strip/title block
    2. Parts list/bill of material
  B. Interpret general notes
    1. Including material
    2. General tolerances
    3. Heat treatment
    4. Pattern information
    5. Processes of manufacture
    6. Requirements of the product
  C. Interpret specific notes
    1. Apply to specific operations
    2. Apply to specific processes of manufacture
    3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
  A. Identify organizations that determine dimension standards
    1. American National Standards Institutes (ANSI)
    2. International Standards Organization (ISO)
  B. Determine dimensions on a drawing
    1. Size dimensions
    2. Location dimensions
  C. Applying dimensions on a drawing
    1. Scale of drawing
    2. Techniques of dimensioning
    3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

B. Methods of expressing tolerances
  1. General tolerances
  2. Limit dimensioning
  3. Plus and minus dimensioning
    a. Unilateral system
    b. Bilateral system
  4. Single-limit dimensioning
  5. Angular tolerances

VI. Identify ANSI Limits and Fits
  A. Fits between mating parts
    1. Clearance fit
    2. Interference fit
    3. Transition fit
    4. Line fit
  B. Limits and fits for cylindrical parts
    1. Running or sliding clearance fits
    2. Locational clearance fits
    3. Transition clearance interference fits
    4. Locational interference fits
    5. Force or shrink fits

WLD-H14-HO3
Describe the Use of Jigs and Fixtures in Layout and Fit-Up
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
    A. General/conventional tolerancing
        1. Definitions of general/conventional tolerancing
            a. Dimension
            b. Reference dimension
            c. Feature
            d. Feature of size
            e. Actual size
            f. Stock size
        2. Maximum material condition
        3. Least material condition
        4. Basic fits
        5. Clearance fit
        6. Allowance
        7. Clearance
        8. Force fit
    B. Geometric dimensioning and tolerancing
        1. Definition of geometric dimensioning and tolerancing
        2. Dimensioning rules
        3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
    A. Explain positional / location tolerances
    B. Identify and use geometric position tolerancing symbols
        1. Position
        2. Concentricity
        3. Symmetry
III. Explain and Use Tolerances of Form Symbols
    A. Explain form tolerances
    B. Identify and use tolerances of form symbols

        1. Straightness
        2. Flatness
        3. Circularity
        4. Cylindrical

IV. Explain and Use Profile Tolerances
    A. Explain profile tolerance
    B. Identify and use profile tolerance symbols
        1. Profile of a line
        2. Profile of a surface
        3. Profile of an arc
        4. Profile of irregular curves
        5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
    A. Explain orientation tolerances
    B. Identify and use orientation tolerance symbols
        1. Parallelism
        2. Perpendicularity
        3. Angularity

VI. Explain and Use Runout Tolerances
    A. Explain runouts
        1. Circular
        2. Total
    B. Identify and use runout tolerances symbols
        1. Circular
        2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    A. Maximum Material Condition (MMC)
    B. Regardless of Feature Size (RFS)
    C. Least Material Condition (LMC)
    D. Datum feature symbol
    E. Datum reference frame concept
        1. Primary datum plane
        2. Secondary datum plane
        3. Tertiary datum plane
    F. Datum target symbol
        1. Target point
        2. Target line
        3. Target area

VIII. Explain and Use the Feature Control Frame
    A. Explain feature control frame
    B. Explain the compartments of a feature control frame
        1. Geometric characteristic symbol
        2. Geometric tolerance
        3. Zone descriptor
        4. Material condition symbol

5. Primary datum reference
6. Secondary datum reference
7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

A. Explain and use additional modifying symbols.
   1. Diameter
   2. Radius R
   3. Reference ( )
   4. Counterbore/spotface L/
   5. Square
   6. Dimension origin O
   7. Slope
   8. Projected tolerance zone
   9. Spherical diameter
   10. Spherical radius
   11. Arc length
   12. Counter sink
   13. Depth
   14. Conical taper
   15. Place, times, or by
   16. Basic dimension

WELDER SERIES

MASTER Technical Module No. WLD-H15

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **BLUEPRINTING, STRUCTURAL LAYOUT AND FIT-UP**
- **TASK:** List the Steps to be Followed When Planning a Job

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand job lists for materials; and,

B. Understand work orders and sequence of work.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Classroom handout
MASTER Handout No. 1 (WLD-H15-HO1)
MASTER Handout No. 2 (WLD-H15-HO2)
MASTER Handout No. 3 (WLD-H15-HO3)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, INC. Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Standard Symbols for Welding, Brazing, and Nondestructive Examination, The American Welding Society, Standard A2-4, Miami, FL, Latest Edition
Welding Handbook, The American Welding Society, Miami, FL, Latest Edition
Symbolic Representation on Drawings, ISO 2553-1984, ANSI International Organization for Standardization, Standard Welds, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition

STUDENT PREPARATION:

The purpose of this program is to assist the student in job planning, bills of material, and sequence of work.

Students should have previously completed the following Technical Modules:

WLD-H14 "Describe the Use of Jigs and Fixtures in Layout and Fit-Up"

INTRODUCTION:

The Course Introduction will Include:

- The essential purpose of planning the work and preparation of a list or bill of materials that will meet work specifications

PRESENTATION OUTLINE:

Instructional Topics:

A. Review the steps in job planning
B. Demonstrate how to select materials based upon drawing specifications
C. How to source and obtain prices for the materials
D. How to use sourcebooks and vendor information for availability and price
E. How to use modern systems for job orders and tracking of raw materials
F. How to deliver the work, close out the job, and bill for payment

Student Activities:

A. Prepare a project summary worksheet to track the progress and cost of the project

PRACTICAL APPLICATION:

This module presents job planning, ordering of materials, job tracking, and closing out the job.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

Emphasis is placed on job planning, obtaining new materials, job tracking, costing, and completion of the job by payment and any necessary follow-up.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-H16) dealing with interpreting structural detail sheets.

WLD-H15-HO1

List the Steps to be Followed When Planning a Job

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand job lists for materials; and,

B. Understand work orders and sequence of work.

MODULE OUTLINE:

Instructional Topics:

A. Review the steps in job planning

B. Demonstrate how to select materials based upon drawing specifications

C. How to source and obtain prices for the materials

D. How to use sourcebooks and vendor information for availability and price

E. How to use modern systems for job orders and tracking of raw materials

F. How to deliver the work, close out the job, and bill for payment

Student Activities:

A. Prepare a project summary worksheet to track the progress and cost of the project

WLD-H15-HO2

List the Steps to be Followed When Planning a Job

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
  A. General notes
  B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
  A. General notes applied
    1. Title strip/title block
    2. Parts list/bill of material
  B. Interpret general notes
    1. Including material
    2. General tolerances
    3. Heat treatment
    4. Pattern information
    5. Processes of manufacture
    6. Requirements of the product
  C. Interpret specific notes
    1. Apply to specific operations
    2. Apply to specific processes of manufacture
    3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
  A. Identify organizations that determine dimension standards
    1. American National Standards Institutes (ANSI)
    2. International Standards Organization (ISO)
  B. Determine dimensions on a drawing
    1. Size dimensions
    2. Location dimensions
  C. Applying dimensions on a drawing
    1. Scale of drawing
    2. Techniques of dimensioning
    3. Placement of dimensions

Name: ______________________________ Date: ____________________

WLD-J4
Verify Joint Preparation
Self-Assessment No. 1

Circle the best answer.

1. Using the SAE system, 1008 indicates
   a. plain carbon steel, 8% carbon
   b. plain carbon steel, 0.8% carbon
   c. plain carbon steel, 0.08% carbon
   d. low chromium steel, 0.08% carbon
   e. none of the above

2. In the SAE system, triple-alloy steels are designated by the numeral _____
   a. 6
   b. 7
   c. 8
   d. 9
   e. none of the above

3. The AISI system uses __________ to indicate the process used to manufacture the steel.
   a. numerical prefixes
   b. numerical suffixes
   c. capital letter prefixes
   d. capital letter suffixes
   e. none of the above

4. Which of the following does NOT increase the tensile strength of steel?
   a. carbon
   b. molybdenum
   c. nickel
   d. all of the above
   e. none of the above

5. Which of the following elements decreases the *toughness* of steel?
   a. cobalt
   b. phosphorus
   c. vanadium
   d. all of the above
   e. none of the above

6. Which of the following elements imparts *fine grain structure* to steel?
   - a. chromium
   - b. manganese
   - c. silicon
   - d. tungsten
   - e. none of the above

7. The AISI prefix B designates that the steel is
   - a. acid bessemer carbon steel
   - b. basic open hearth carbon steel
   - c. acid open hearth carbon steel
   - d. brass
   - e. none of the above

8. __________ Steels have their own alphabetic classification system.
   - a. stainless
   - b. low carbon
   - c. tool
   - d. austenitic
   - e. none of the above

9. __________ stainless steel can not be hardened by quenching.
   - a. austenitic
   - b. ferritic
   - c. martensitic
   - d. all of the above
   - e. none of the above

10. Which of the following metals is magnetic?
   - a. phosphorus
   - b. silicon
   - c. sulfur
   - d. all of the above
   - e. none of the above

WLD-J4
Verify Joint Preparation
Self-Assessment No. 1 Answer Key

1. c

2. c

3. c

4. d

5. a

6. b

7. a

8. c

9. a

10. e

Name: ______________________________ Date: ____________________

WLD-J4
Verify Joint Preparation
Self-Assessment No. 2

Circle the best answer.

1. In __________ casting, the mold is composed of sand and resin.
    a. green-sand
    b. shell
    c. V-process
    d. squeeze
    e. none of the above

2. Which of the following is NOT a method of injecting material into a mold?
    a. gravitic flow
    b. pressure
    c. centrifugal force
    d. all of the above
    e. none of the above

3. What is the skin effect?
    a. the vacuoles created when the surface of a casting cools faster than its interior
    b. the thin, weak, exterior layer on castings caused by improper mixing of alloys
    c. the layers of metal formed in die casting
    d. abrasions caused by excessive polishing of the casting
    e. goose bumps

4. Die castings should be designed with __________ to relieve cooling stresses.
    a. cores of simple shapes
    b. heavy sections
    c. small cores
    d. uniform wall thicknesses
    e. none of the above

5. Which of the following is a major problem of the hot extrusion process?
    a. cost of glass-powder lubricants
    b. graphite lubricants contaminating the billet
    c. construction of the equipment
    d. scarcity of metals that can be successfully extruded
    e. none of the above

6. Extrusion generates __________ force, but not __________ force.
   a. tensile - compressive
   b. tensile - shear
   c. compressive - shear
   d. compressive - tensile
   e. none of the above

7. Plasma cutters can generate heat in excess of __________.
   a. 20,000°F
   b. 30,000°F
   c. 40,000°F
   d. 80,000°F
   e. 120,000°F

WLD-J4
Verify Joint Preparation
Self-Assessment No. 2 Answer Key

1. b

2. d

3. c

4. d

5. c

6. d

7. c

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Welding Series
INSTRUCTOR'S HANDBOOK
DUTIES K THROUGH L2

Supported by the National Science Foundation's Advanced Technological Education Program

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

Duty K

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on llife of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-K1

WELDER SERIES

MASTER Technical Module No. WLD-K01

SUBJECT: WELDING TECHNICIAN TIME: 15 HOURS

- **DUTY:** **OXYACETYLENE CUTTING AND WELDING**
- **TASK:** Identify and Describe the Function of Each Piece of Equipment

---

OBJECTIVE(S):

Upon completion of this unit, the student will be able to:

A. Understand basic fundamentals and scientific principles involved in the welding process;

B. Demonstrate the safe handling, use, and storage of oxygen and fuel gas cylinders;

C. Identify oxygen and fuel gas cylinders, oxygen and fuel gas regulators, torch handles, welding tips, cutting torch assemblies, and friction lighters;

D. Use a tip cleaner on oxyacetylene equipment;

E. Demonstrate the assembly and function of each piece of oxyfuel equipment; and,

F. Perform leak detection, safe startup, lighting, and shutdown of equipment.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on Oxyacetylene Safety, Equipment nomenclature, and Basic Procedures
Transparencies will be used to emphasize each subject
Hobart Institute Video Material
Classroom handouts consisting of student worksheets and base metals and filler metals
Personal protective equipment
Oxyfuel welding equipment
Oxygen and fuel gas cylinders
Oxygen and fuel gas regulators
Torch handles
Welding and cutting tips
Cutting torch assemblies
Lighters
Selection of filler metals and oxyfuel welding rod
Selection of base metals for welding and cutting
Welding shop tools

MASTER Handout (WLD-K1-HO)
MASTER Laboratory Aid (WLD-K1-LA)
MASTER Laboratory Worksheet No. 1 (WLD-K1-LW1)
MASTER Laboratory Worksheet No. 2 (WLD-K1-LW2)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Keller's Official OSHA Safety Handbook, T.J Keller and Associates, Inc., ISBN 1-877798-21-5, Latest Edition
Operator's Manual for Oxyfuel Gas Cutting, ANSI/AWS C4.1G, Latest Edition
Welding Handbook, Volume One, Welding Technology WHB-1.8, Latest Edition
Specification for Qualification and Certification for Entry Level Welders, AWS QC10, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses.

INTRODUCTION:

The Course Introduction will Include:

- An overview of a fast growing technical field with many career opportunities and excellent pay
- Class demonstrations of safe welding operations
- A discussion on training activities resulting in an increase of skill and knowledge leading to certification in related program areas, becoming a more valuable employee

PRESENTATION OUTLINE:

Instruction Topics:

A. Identify oxygen and fuel gas cylinders
B. Describe preventive and protective measures in use of tools and equipment
C. Illustrate the function of oxygen equipment, fuel gas regulators, and gages
D. Demonstrating pressure adjustments, and inlet/outlet connections
E. Emphasize nomenclature and purpose of components.
F. Demonstrate the selection and use of torches, tips, and friction lighters
G. Illustrate techniques for start up, lighting, and shut down of equipment
H. Introduce methods associated with cutting and welding

Student Activities:

A. Identify, understand, and demonstrate the safe use of equipment at the introductory level.
B. Observe and be coached by the instructor in the introductory set up and shutdown of oxyacetylene gas welding equipment.

PRACTICAL APPLICATION:

Students will set-up and shut-down oxyacetylene equipment in a safe and cautious manner, wearing personal protective equipment, and being aware of the location of gas hoses and the "direction of the oxygen stream and sparks" which could possibly cause fires.

EVALUATION AND/OR VERIFICATION:

Two written examinations and a set-up and a shut-down procedural laboratory exercise will be given to determine individual student progress.

SUMMARY:

In the oxyfuel welding process, heat is transferred from a flame to the work by forced connection and radiation. The flame is produced by supplying nearly equal volumes of oxygen and acetylene to a torch, serving the function of bringing together nearly equal volumes of the fuel gas and oxygen, mix them efficiently and pass them through a nozzle to form a flame with characteristics suitable for welding. The chemical characteristics of the flame can be altered to suit the requirements of the welding process.

Emphasis will be upon oxyacetylene equipment nomenclature and the safety precautions for using oxygen, fuel gas cylinders, regulators, and hoses. Students will understand the purpose, proper use, and maintenance of all equipment.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-K2) dealing with identifying the safety hazards.

WLD-K1-HO
Identify and Describe the Function of Each Piece of Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit, the student will be able to:

A. Understand basic fundamentals and scientific principles involved in the welding process;
B. Demonstrate the safe handling, use, and storage of oxygen and fuel gas cylinders;
C. Identify oxygen and fuel gas cylinders, oxygen and fuel gas regulators, torch handles, welding tips, cutting torch assemblies, and friction lighters;
D. Use a tip cleaner on oxyacetylene equipment;
E. Demonstrate the assembly and function of each piece of oxyfuel equipment; and,
F. Perform leak detection, safe startup, lighting, and shutdown of equipment.

MODULE OUTLINE:

Instruction Topics:

A. Identify oxygen and fuel gas cylinders
B. Describe preventive and protective measures in use of tools and equipment
C. Illustrate the function of oxygen equipment, fuel gas regulators, and gages
D. Demonstrating pressure adjustments, and inlet/outlet connections
E. Emphasize nomenclature and purpose of components.
F. Demonstrate the selection and use of torches, tips, and friction lighters
G. Illustrate techniques for start up, lighting, and shut down of equipment
H. Introduce methods associated with cutting and welding

Student Activities:

A. Identify, understand, and demonstrate the safe use of equipment at the introductory level.
B. Observe and be coached by the instructor in the introductory set up and shutdown of oxyacetylene gas welding equipment.

WLD-K1-LA
Identify and Describe the Function of Each Piece of Equipment
Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K1-LW1
Identify and Describe the Function of Each Piece of Equipment
Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?

2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?

3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?

4. What are the steps in preparing to cut with oxyacetylene?

5. What are the steps in lighting the torch?

6. What are the steps in cutting metal with the torch?

7. What are the steps in extinguishing the torch?

8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
    a. Use goggles or shield with a number five shade.
    b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
    c. When lighting the torch, direct the torch away from yourself and other personnel.
    d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
    e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
    f. Never cut on containers that have contained flammable or toxic substances.
    g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
    h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.
k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
l. Never use any cylinder, full or empty, as a roller or support.
m. Never use oxygen as though it were compressed air.
n. Do not handle oxygen cylinders on the same platform with oil.
o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
p. Store oxygen cylinders separately from fuel gas cylinders.
q. Always keep empty cylinders separate from full cylinders.
r. Mark all empty cylinders as such after use.
s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
t. Never bring any arc or flame close to or directly into contact with a cylinder.
u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
    a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
    b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
    c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
    d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
    a. Obtain the proper size cutting tip.
        (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
        (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
    b. Screw the cutting torch head in place, hand-tight only.
    c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
    d. Attach the regulators, hoses, torch, and correct-sized torch tip.
    e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
    f. Make sure all cutting torch valves are initially closed.
    g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
    h. Open the acetylene torch valve. Turn the acetylene torch valve off.

- i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
- j. Turn the acetylene torch valve off.
- k. Turn both oxygen torch valves on.
- l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
- m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   - a. Put on gloves:
   - b. Put on welding goggles.
   - c. Open the torch acetylene valve one-half turn.
   - d. Immediately light the torch with a *friction lighter only.*
   - e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   - f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
     - (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
     - (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   - a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
     - (1) Cutting tip size.
     - (2) Oxygen operating pressure.
     - (3) Acetylene operating pressure.
     - (4) Preheat flame type.
     - (5) Size of preheat flame
   - b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
   - c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
   - d. Select the correct torch angle.
     - (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
     - (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

    (3) For *holes*, the torch must be held perpendicular to the base metal throughout the cut.

  e. Cut at the proper travel speed. At the *correct travel speed*, the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed*, the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)
  f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
  a. Close the torch acetylene valve, thus extinguishing the flame.
  b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
  a. Close the oxygen cylinder valve.
  b. Close the acetylene cylinder valve.
  c. Open the torch acetylene valve and bleed the acetylene from the line.
  d. Close the torch acetylene valve.
  e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
  f. Open the torch oxygen valve and bleed the oxygen from the line.
  g. Close the torch oxygen valve.
  h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K1-LW2

Identify and Describe the Function of Each Piece of Equipment

Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

Name: ______________________________ Date: ___________________________

WLD-K1
Identify and Describe the Function of Each Piece of Equipment
Self-Assessment No. 1

Circle the best answer.

1. Which of the following can be used to ignite an oxyacetylene torch?
   a. Matches
   b. A cigarette lighter
   c. A spark or friction lighter
   d. Any of the above
   e. None of the above

2. Technician A says that they can cut into an old gasoline can with the torch. Technician B says that containers of flammable or toxic substances should never be cut with a torch. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

3. If adequate ventilation is unavailable, the technician should:
   a. Cut the metal anyway; ventilation is not important.
   b. Cut the metal while wearing a respirator.
   c. Cut the metal while wearing a heavy-duty dust mask.
   d. Refuse to make the cut.

4. Acetylene operating pressures must be kept at or below:
   a. 5 psi
   b. 15 psi
   c. 25 psi
   d. Acetylene operating pressures are immaterial.

5. Acetylene hoses are __________; acetylene fittings are __________
   a. Red - left-handed
   b. Blue - left-handed
   c. Red - right-handed
   d. Blue - left-handed
   e. None of the above

6. All cylinders should be secured except when:
   a. Transporting them.
   b. Storing them.
   c. Using them.
   d. Always secure cylinders with chains or in permanent racks.
   e. Securing cylinders is unnecessary.

7. Technician A says that oxygen cylinders should be stored well away from fuel gas cylinders. Technician B says that separate storage is unnecessary. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

8. The maximum safe withdrawal rate for acetylene cylinders is:
   a. One fourth of current content per hour.
   b. One fifth of current content per hour.
   c. One seventh of current content per hour.
   d. One tenth of current content per hour.
   e. None of the above

9. Technician A says that only oxygen-specific regulators can be used on oxygen cylinders. Technician B says that it is acceptable to use oxygen regulators on other gas cylinders. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

10. Which of the following can be cut with an oxyacetylene torch?
   a. Aluminum
   b. Copper
   c. Chromium
   d. All of the above
   e. None of the above

11. Technician A says that the acetylene cylinder's valve should be opened all the way. Technician B says that the oxygen cylinder's valve should be opened no more than one full turn. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

12. Before attaching the regulators to the cylinder valves:
   a. Clean the nipples with acetone.
   b. Crack the valves to blow out any dirt.
   c. Lubricate the threads with oil.
   d. All of the above
   e. None of the above

13. Technician A says that they must reduce the acetylene flow until the flame just starts to produce black smoke around its edges. Technician B says that the acetylene flow must then be increased until the smoke disappears. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

14. Dirty orifices on the cutting tip can produce:
   a. Wide kerfs.
   b. Adherent slag.
   c. Rough cut appearance.
   d. All of the above.
   e. None of the above

15. Technician A says that, for cutting holes, the torch must be held parallel to the base metal throughout the cut. Technician B says that square cuts require the torch to be held at 45° to the base metal. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

16. Lag lines are the result of
   a. Correct travel speed.
   b. Too great a travel speed.
   c. Too slow a travel speed.
   d. Incorrect torch angle.
   e. None of the above

17. When extinguishing the torch, Technician A says that the acetylene torch valve should be closed first. Technician B says that the oxygen torch valve should be closed first. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

18. Good oxy-fuel cuts require an oxygen purity of at least:
   a. 99.5%.
   b. 95.9%.
   c. 59.9%.
   d. None of the above.

19. Both acetylene and oxygen lines should be __________ when closing down the work station.
   a. Removed
   b. Cleaned with acetone
   c. Bled free of gas or fuel
   d. All of the above
   e. None of the above

20. Technician A says that since B is left-handed, B should cut from left to right. Technician B says that the pre-heat flame should still be from 1/6" to 1/2" from the base metal, regardless of the direction of travel. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

WLD-K1
Identify and Describe the Function of Each Piece of Equipment
Self-Assessment No. 1 Answer Key

1.	c
2.	b
3.	b
4.	b
5.	a
6.	d
7.	a
8.	c
9.	a
10.	e
11.	d
12.	b
13.	c
14.	d
15.	d
16.	b
17.	a
18.	a
19.	c
20.	c

Name: ______________________________ Date: _________________________

WLD-K1
Identify and Describe the Function of Each Piece of Equipment
Self-Assessment No. 2

1. What is the major difference between a brazed joint and a welded joint?

2. What two conditions determines whether the joint is brazed or welded?

3. How does flux act as a guide to the temperature of the joint?

4. What is the color of the plate when it is at the proper temperature for welding?

5. Is brazing stronger than fusion welding?

6. For silver soldering: what is a 3x flame?

7. What alloys are contained in typical silver soldering?

8. How can material be prepared for silver soldering?

9. Is it possible to make fillets when using silver soldering alloys?

WELDER SERIES

MASTER Technical Module No. WLD-K02

SUBJECT: **WELDING TECHNICIAN** **TIME: 6 HOURS**

- **DUTY:** **OXYACETYLENE CUTTING AND WELDING**
- **TASK:** Identify the Safety Hazards

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Discuss the safety hazards associated with ignition and combustion;
B. Discuss the effect of an oxygen enriched environment;
C. Discuss the importance of ventilation in the oxyacetylene area;
D. Illustrate how to check the connections for leaks;
E. Review the use of check valves and flash arresters;
F. Discuss the importance of making sure o-rings are in good condition;
G. Demonstrate practice of indicators and detection measures for gas leaks;
H. Explain the function of Material Safety Data Sheets; and,
I. Explain the classes of fires and the types of extinguishers.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on Oxyacetylene Safety, Equipment nomenclature, and Basic Procedures
Transparencies will be used to emphasize each subject
Hobart Institute Video Material
Classroom handouts consisting of student worksheets and base metals and filler metals
Personal protective equipment
Oxyfuel welding equipment
Oxygen and fuel gas cylinders
Oxygen and fuel gas regulators
Torch handles
Welding and cutting tips
Cutting torch assemblies
Lighters
Selection of filler metals and oxyfuel welding rod
Selection of base metals for welding and cutting
Welding shop tools
MASTER Handout No. 1 (WLD-K2-HO1)

MASTER Handout No. 2 (WLD-K2-HO2)
MASTER Laboratory Aid (WLD-K2-LA)
MASTER Laboratory Worksheet No. 1 (WLD-K2-LW1)
MASTER Laboratory Worksheet No. 2 (WLD-K2-LW2)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Keller's Official OSHA Safety Handbook, T.J Keller and Associates, Inc., ISBN 1-877798-21-5, Latest Edition
Operator's Manual for Oxyfuel Gas Cutting, ANSI/AWS C4.1G, Latest Edition
Welding Handbook, Volume One, Welding Technology WHB-1.8, Latest Edition
Specification for Qualification and Certification for Entry Level Welders, AWS QC10, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses.

WLD-K1 "Identify and Describe the Function of Each Piece of Equipment"

INTRODUCTION:

The Course Introduction will Include:

- An overview of the welding profession and opportunities in a fast growing technical field with many opportunities and excellent pay
- A class demonstration of effective safety techniques
- A discussion on areas of welding practice that will enhance skill and knowledge leading to certification.

PRESENTATION OUTLINE:

Instruction Topics:

A. Identify safety hazards
B. Demonstrate preventive and protective measures
C. Describe the function of Material Safety and Data Sheets
D. Explain and practice safe lockout/tagout procedures
E. Practice safe work procedures around electrical hazards
F. Use respiratory protection equipment
G. Safe use of welders hand tools and power tools
H. Demonstrate how to set up and connect equipment
I. Demonstrate how to make pressure adjustments

Student Activities:

A. Inspection of welding shop for all possible safety hazards.
B. Select and demonstrate proper use of personal protective equipment, to include eye protection with required shade of lens, hearing protection, radiation and heat protection methods, and respiratory protection
C. Practice safe methods for lighting, safe use of ladders and scaffolds
D. Practice safe methods for electrical hazards and protection against shock
E. Review HazCom Standards and locate Material Safety Data Sheets

PRACTICAL APPLICATION:

The student will set-up oxyacetylene equipment in a safe and cautious manner, wearing safety equipment, and being aware of the location of gas hoses and the direction of "the oxygen stream and sparks". Student will practice the use of respiratory equipment, all safety protection equipment, and use of welders hand tools and power tools.

EVALUATION AND/OR VERIFICATION:

Written examinations will be given during this module to determine student progress. Students will practice safe operational procedures for instructor evaluation.

SUMMARY:

Emphasis will be on safe handling and operation of equipment, tools, and oxyfuel containers and hoses. Students will demonstrate teamwork and assisting others in carrying out responsibilities to prevent injuries, accidents, fires, and prepare the appropriate coordinated response in emergencies.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-K3) dealing with describing preventive and/or protective measures.

WLD-K2-HO1
Identify the Safety Hazards
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Discuss the safety hazards associated with ignition and combustion;
B. Discuss the effect of an oxygen enriched environment;
C. Discuss the importance of ventilation in the oxyacetylene area;
D. Illustrate how to check the connections for leaks;
E. Review the use of check valves and flash arresters;
F. Discuss the importance of making sure o-rings are in good condition;
G. Demonstrate practice of indicators and detection measures for gas leaks;
H. Explain the function of Material Safety Data Sheets; and,
I. Explain the classes of fires and the types of extinguishers.

PRESENTATION OUTLINE:

Instruction Topics:

A. Identify safety hazards
B. Demonstrate preventive and protective measures
C. Describe the function of Material Safety and Data Sheets
D. Explain and practice safe lockout/tagout procedures
E. Practice safe work procedures around electrical hazards
F. Use respiratory protection equipment
G. Safe use of welders hand tools and power tools
H. Demonstrate how to set up and connect equipment
I. Demonstrate how to make pressure adjustments

Student Activities:

A. Inspection of welding shop for all possible safety hazards.
B. Select and demonstrate proper use of personal protective equipment, to include eye protection with required shade of lens, hearing protection, radiation and heat protection methods, and respiratory protection
C. Practice safe methods for lighting, safe use of ladders and scaffolds
D. Practice safe methods for electrical hazards and protection against shock
E. Review HazCom Standards and locate Material Safety Data Sheets

WLD-K2-HO2
Identify the Safety Hazards
Attachment 2: **MASTER** Handout No. 2

INTRODUCTION:

Welding is considered to be a hazardous occupation. Welding operations are used to cut, repair, and fabricate. Successful use of the welding torch, welding apparatus, and welding machines is based in safe operating procedures.

MODULE OUTLINE:

DON'T CARRY A BOMB IN YOUR POCKET!

NEVER carry a butane lighter into a welding area. These are mini-Molotov cocktails.

I. Safety Procedures Specific to the Welding Process
  A. Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.
    1. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
    2. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
    3. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask
    4. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.
  B. Electrical shock can be avoided by following specific safety precautions.
    1. Do not touch live electrical parts.
    2. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
    3. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
    4. Be sure all electrical connections are tight, dean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
    5. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
    6. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.

    7. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
    8. Shut off electrical power when working on welding equipment.

C. Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

    1. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
    2. Cover all skin surfaces. Keep shirt sleeves rolled down.
    3. Wear cuffless pants to eliminate spatter traps.
    4. Wear leather boots. Pant legs should cover boot tops.
    5. Wear clean clothing. Oil- and grease-stained clothes will tend to ignite from welding spatter.
    6. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
    7. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
    8. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
    9. Wear a 100% cotton cap to protect the head from sparks or spatter.
    10. Wear long-gauntlet leather gloves.
    11. Do not touch hot metal with bare hands. Use tongs or pliers and wear leather gloves.
    12. Protect nearby workers from exposure to the welding arc by putting up shields.
    13. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (See Figure 1).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	Minimum Shade No.	Suggested Shade*
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to the next lighter shade until you find one which gives you sufficient view of the arc zone without exerting a strain on your eyes.

FIGURE 1 FILTER RECOMMENDATIONS

D. Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

1. If possible, weld in specially designated areas or enclosures of noncombustible construction.
2. Remove combustibles from the work area by at least 35 feet if possible.
3. Cover combustibles that cannot be removed from the welding area with tight-fitting, flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.
4. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.
5. If combustibles cannot be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.
6. Do not weld on materials having either a coating or internal structure that is combustible.
7. Place hot scrap and slag in non-combustible containers.
8. Ensure that fire extinguishers are available nearby.
9. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.
10. Follow all company safety procedures regarding welding in hazardous areas.

E. Specific Safety Precautions for Oxyacetylene Equipment
CAUTION: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment:

1. Use goggles or shield with a number five shade.
2. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
3. When lighting the torch, direct the torch away from yourself and other personnel.
4. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
5. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
6. Never cut on containers that have contained flammable or toxic substances.
7. Either move work away from or protect wooden or other flammable materials which may be close to the work.
8. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.
9. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.

10. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
11. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

F. Specific Safety Precautions for Acetylene and Oxygen Cylinders

CAUTION: Handle acetylene and oxygen cylinders carefully:

1. Keep acetylene operating pressures at or below 15 psi.
2. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
3. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
4. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene, hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
5. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
6. Do not use pipe-fitting compounds or thread lubricants for making connections.
7. Never use a cylinder that is leaking.
8. Store and transport cylinders in the upright position.
9. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
10. Never tamper with fusible plugs or other safety devices on cylinders.
11. To open and dose acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
12. Never use any cylinder, full or empty, as a roller or support.
13. Never use oxygen as though it were compressed air.
14. Do not handle oxygen cylinders on the same platform with oil.
15. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
16. Store oxygen cylinders separately from fuel gas cylinders.
17. Always keep empty cylinders separate from full cylinders.
18. Mark all empty cylinders as such after use.
19. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
20. Never bring any arc or flame close to or directly into contact with a cylinder.
21. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment.

If additional flow is needed, then manifold the required number of cylinders together.

G. Specific Safety Precautions for Regulator Burnout (R.B.O.)

CAUTION: Avoid potentially deadly regulator burnout (R.B.O.). Regulator burnout is a spontaneous explosion that happens when a torch is being lit. To minimize the risk of R.B.O., follow these safety precautions:

1. "Crack" the oxygen cylinder valve (open it slightly) before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
2. Use only oxygen regulators to control oxygen supply. A pressure-reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal, dust, and other combustibles can cause regulator burnout. Never use an oxygen regulator for other gases.
3. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
4. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

II. Describe the SMAW Process

Shielded Metal Arc Welding is a welding process which joins metals by heating them with an arc between a covered metal electrode and the metals being joined. Shielding is obtained from the decomposition (breakdown) of the electrode covering. Pressure is not used and filler metal is obtained from the electrode. The electric arc flowing across an air gap produces very intense heat and light. An electric arc has been measured at 10,000°F. Considering that steel melts at around 2800°F, the electric arc is indeed a very fast and efficient heat source for melting steel when welding.

III. Describe the Oxyacetylene Cutting and Welding Process

Oxyacetylene cutting requires the use of specific procedures and specific techniques in order to work safely and to produce acceptable cuts. Proper flame adjustments, torch angles, and flame-to-work distances must be maintained in order to produce good cuts. Oxyacetylene cutting can be done from both fixed cutting stations and from portable cutting stations. The key operations to oxyacetylene cutting are as follows:

1. Prepare to cut.
2. Light the torch.
3. Cut metal with the torch.

4. Extinguish the torch.

HOW TO SELECT THE CORRECT NUMBER OF ACETYLENE CYLINDERS

To determine the number of cylinders required for proper manifold operation, follow the guidelines below:

1. The number of cylinders in the manifold is determined by the volume of gas in cubic feet per hour required. Determine the cubic feet per hour required for the largest tip used and multiply that by the number of torches or stations in operation at the same time. This will give the total volume of each gas required per hour.

2. The manifold should have enough. cylinders to provide a minimum of one day's requirements

3. Maximum acetylene withdrawal for continuous operation is 1/7 (of 14%) of each cylinder capacity per hour. The chart allows for 7.8% excess capacity

CFH Acetylene withdrawal per hour required	Number of 300 cubic foot cylinders per manifold
40	1
80	2
120	3
160	4
200	5
240	6
280	7
320	8
360	9
400	10
440	11
480	12
520	13
560	14
600	15
640	16
680	17
720	18
760	19
800	20

Acetylene Cylinder Manifold Guide

IV. Describe the GTAW (Heliarc) Process
V. Describe the GMAW (MIG) Process
VI. Describe the Band/Flash Welding Machine and Process

WLD-K2-LA
Identify the Safety Hazards
Attachment 3: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K2-LW1
Identify the Safety Hazards
Attachment 4 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?
2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?
3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?
4. What are the steps in preparing to cut with oxyacetylene?
5. What are the steps in lighting the torch?
6. What are the steps in cutting metal with the torch?
7. What are the steps in extinguishing the torch?
8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
    a. Use goggles or shield with a number five shade.
    b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
    c. When lighting the torch, direct the torch away from yourself and other personnel.
    d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
    e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
    f. Never cut on containers that have contained flammable or toxic substances.
    g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
    h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

   - i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
   - j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
   - k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
   - a. Keep acetylene operating pressures at or below 15 psi.
   - b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   - c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   - d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   - e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   - f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   - g. Never use a cylinder that is leaking.
   - h. Store and transport cylinders in the upright position.
   - i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   - j. Never tamper with fusible plugs or other safety devices on cylinders.
   - k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   - l. Never use any cylinder, full or empty, as a roller or support.
   - m. Never use oxygen as though it were compressed air.
   - n. Do not handle oxygen cylinders on the same platform with oil.
   - o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
   - p. Store oxygen cylinders separately from fuel gas cylinders.
   - q. Always keep empty cylinders separate from full cylinders.
   - r. Mark all empty cylinders as such after use.
   - s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   - t. Never bring any arc or flame close to or directly into contact with a cylinder.
   - u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
   a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
   b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
   c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
   d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
   a. Obtain the proper size cutting tip.
      (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
      (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
   b. Screw the cutting torch head in place, hand-tight only.
   c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
   d. Attach the regulators, hoses, torch, and correct-sized torch tip.
   e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
   f. Make sure all cutting torch valves are initially closed.
   g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
   h. Open the acetylene torch valve. Turn the acetylene torch valve off.

- i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
- j. Turn the acetylene torch valve off.
- k. Turn both oxygen torch valves on.
- l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
- m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   - a. Put on gloves.
   - b. Put on welding goggles.
   - c. Open the torch acetylene valve one-half turn.
   - d. Immediately light the torch with a *friction lighter only.*
   - e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   - f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
     - (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
     - (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   - a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
     - (1) Cutting tip size.
     - (2) Oxygen operating pressure.
     - (3) Acetylene operating pressure.
     - (4) Preheat flame type.
     - (5) Size of preheat flame
   - b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
   - c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
   - d. Select the correct torch angle.
     - (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
     - (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

(3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed*, the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. Open the torch acetylene valve and bleed the acetylene from the line.
   d. Close the torch acetylene valve.
   e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
   f. Open the torch oxygen valve and bleed the oxygen from the line.
   g. Close the torch oxygen valve.
   h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K2-LW2
Identify the Safety Hazards
Attachment 5: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

Name: ______________________________ Date: ___________________________

WLD-K2
Identify the Safety Hazards
Self-Assessment No. 1

Circle the best answer.

1. Which of the following can be used to ignite an oxyacetylene torch?
   a. Matches
   b. A cigarette lighter
   c. A spark or friction lighter
   d. Any of the above
   e. None of the above

2. Technician A says that they can cut into an old gasoline can with the torch. Technician B says that containers of flammable or toxic substances should never be cut with a torch. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

3. If adequate ventilation is unavailable, the technician should:
   a. Cut the metal anyway; ventilation is not important.
   b. Cut the metal while wearing a respirator.
   c. Cut the metal while wearing a heavy-duty dust mask.
   d. Refuse to make the cut.

4. Acetylene operating pressures must be kept at or below:
   a. 5 psi.
   b. 15 psi.
   c. 25 psi.
   d. Acetylene operating pressures are immaterial.

5. Acetylene hoses are __________; acetylene fittings are __________.
   a. Red - left-handed
   b. Blue - left-handed
   c. Red - right-handed
   d. Blue - left-handed
   e. None of the above

6. All cylinders should be secured except when:
   a. Transporting them.
   b. Storing them.
   c. Using them.
   d. Always secure cylinders with chains or in permanent racks.
   e. Securing cylinders is unnecessary.

7. Technician A says that oxygen cylinders should be stored well away from fuel gas cylinders. Technician B says that separate storage is unnecessary. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

8. The maximum safe withdrawal rate for acetylene cylinders is:
   a. One fourth of current content per hour.
   b. One fifth of current content per hour.
   c. One seventh of current content per hour.
   d. One tenth of current content per hour.
   e. None of the above

9. Technician A says that only oxygen-specific regulators can be used on oxygen cylinders. Technician B says that it is acceptable to use oxygen regulators on other gas cylinders. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

10. Which of the following can be cut with an oxyacetylene torch?
   a. Aluminum
   b. Copper
   c. Chromium
   d. All of the above
   e. None of the above

11. Technician A says that the acetylene cylinder's valve should be opened all the way. Technician B says that the oxygen cylinder's valve should be opened no more than one full turn. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

12. Before attaching the regulators to the cylinder valves:
    a. Clean the nipples with acetone.
    b. Crack the valves to blow out any dirt.
    c. Lubricate the threads with oil.
    d. All of the above
    e. None of the above

13. Technician A says that they must reduce the acetylene flow until the flame just starts to produce black smoke around its edges. Technician B says that the acetylene flow must then be increased until the smoke disappears. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

14. Dirty orifices on the cutting tip can produce:
    a. Wide kerfs.
    b. Adherent slag.
    c. Rough cut appearance.
    d. All of the above.
    e. None of the above

15. Technician A says that, for cutting holes, the torch must be held parallel to the base metal throughout the cut. Technician B says that square cuts require the torch to be held at 45° to the base metal. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

16. Lag lines are the result of
    a. Correct travel speed.
    b. Too great a travel speed.
    c. Too slow a travel speed.
    d. Incorrect torch angle.
    e. None of the above

17. When extinguishing the torch, Technician A says that the acetylene torch valve should be closed first. Technician B says that the oxygen torch valve should be closed first. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

18. Good oxy-fuel cuts require an oxygen purity of at least:
   a. 99.5%.
   b. 95.9%.
   c. 59.9%.
   d. None of the above.

19. Both acetylene and oxygen lines should be __________ when closing down the work station.
   a. Removed
   b. Cleaned with acetone
   c. Bled free of gas or fuel
   d. All of the above
   e. None of the above

20. Technician A says that since B is left-handed, B should cut from left to right. Technician B says that the pre-heat flame should still be from 1/6" to 1/2" from the base metal, regardless of the direction of travel. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

WLD-K2
Identify the Safety Hazards
Self-Assessment No. 1 Answer Key

1.	c	11.	d
2.	b	12.	b
3.	b	13.	c
4.	b	14.	d
5.	a	15.	d
6.	d	16.	b
7.	a	17.	a
8.	c	18.	a
9.	a	19.	c
10.	e	20.	c

Name: ______________________ Date: ______________________

WLD-K2
Identify the Safety Hazards
Self-Assessment No. 2

1. What is the major difference between a brazed joint and a welded joint?

2. What two conditions determines whether the joint is brazed or welded?

3. How does flux act as a guide to the temperature of the joint?

4. What is the color of the plate when it is at the proper temperature for welding?

5. Is brazing stronger than fusion welding?

6. For silver soldering: what is a 3x flame?

7. What alloys are contained in typical silver soldering?

8. How can material be prepared for silver soldering?

9. Is it possible to make fillets when using silver soldering alloys?

____

____

____

Name ______________________________ Date ______________________

WLD-K2
Identify the Safety Hazards
Self-Assessment No. 3

Circle the best answer.

1. Technician A says that they can cut into an old water can with the torch. Technician B says that containers of flammable or toxic substances should never be cut with a torch. Who is correct?
   A. Technician A only
   B. Technician B only
   C. Both Technicians A and B
   D. Neither Technician A nor B

2. Before attaching the regulators to the cylinder valves:
   A. Clean the nipples with acetone.
   B. Crack the valves to blow out any dirt.
   C. Lubricate the threads with oil.
   D. All of the above
   E. None of the above

3. Technician A says that since B is left-handed, B should cut from left to right. Technician B says that the pre-heat flame should still be from 1/6" to 1/2" from the base metal, regardless of the direction of travel. Who is correct?
   A. Technician A only
   B. Technician B only
   C. Both Technicians A and B
   D. Neither Technician A nor B

4. If adequate ventilation is unavailable, the technician should:
   A. Cut the metal anyway; ventilation is not important.
   B. Cut the metal while wearing a respirator.
   C. Cut the metal while wearing a heavy-duty dust mask.
   D. Refuse to make the cut.

5. Technician A says that they must reduce the acetylene flow until the flame just starts to produce black smoke around its edges. Technician B says that the acetylene flow must then be increased until the smoke disappears. Who is correct?
   A. Technician A only
   B. Technician B only
   C. Both Technicians A and B
   D. Neither Technician A nor B

6. Acetylene operating pressures must be kept at or below:
   - A. 5 psi
   - B. 15 psi
   - C. 25 psi
   - D. Acetylene operating pressures are immaterial.

7. Dirty orifices on the cutting tip can produce:
   - A. Wide kerfs.
   - B. Adherent slag.
   - C. Rough cut appearance.
   - D. All of the above.
   - E. None of the above

8. Acetylene hoses are __________; acetylene fittings are __________
   - A. Red - left-handed
   - B. Blue - left-handed
   - C. Red - right-handed
   - D. Blue - left-handed

9. Technician A says that, for cutting holes, the torch must be held parallel to the base metal throughout the cut. Technician B says that square cuts require the torch to be held at 45° to the base metal. Who is correct?
   - A. Technician A only
   - B. Technician B only
   - C. Both Technicians A and B
   - D. Neither Technician A nor B

10. Lag lines are the result of
    - A. Correct travel speed.
    - B. Too great a travel speed.
    - C. Too slow a travel speed.
    - D. Incorrect torch angle.
    - E. None of the above

11. All cylinders should be secured except when:
    - A. Transporting them.
    - B. Storing them.
    - C. Using them.
    - D. Always secure cylinders with chains or in permanent racks.
    - E. Securing cylinders is unnecessary.

12. Technician A says that the acetylene cylinder's valve should be opened all the way. Technician B says that the oxygen cylinder's valve should be opened no more than one full turn. Who is correct?
A. Technician A only
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

13. Which of the following can be used to ignite an oxyacetylene torch?
A. Matches
B. A cigarette lighter
C. A spark or friction lighter
D. Any of the above
E. None of the above

14. Both acetylene and oxygen lines should be __________ when closing down the work station.
A. Removed
B. Cleaned with acetone
C. Bled free of gas or fuel
D. All of the above

15. Technician A says that only oxygen-specific regulators can be used on oxygen cylinders. Technician B says that it is acceptable to use oxygen regulators on other gas cylinders. Who is correct?
A. Technician A only
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

16. When extinguishing the torch, Technician A says that the acetylene torch valve should be closed first. Technician B says that the oxygen torch valve should be closed first. Who is correct?
A. Technician A only
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

17. Good oxy-fuel cuts require an oxygen purity of at least:
A. 99.5%.
B. 95.9%.
C. 59.9%.
D. None of the above.

18. Technician A says that oxygen cylinders should be stored well away from fuel gas cylinders. Technician B says that separate storage is unnecessary. Who is correct?
    A. Technician A only
    B. Technician B only
    C. Both technicians A and B
    D. Neither Technician A nor B

19. The maximum safe withdrawal rate for acetylene cylinders is:
    A. One fourth of current content per hour
    B. One fifth of current content per hour
    C. One seventh of current content per hour
    D. One tenth of current content per hour

20. Which of the following *can* be cut with an oxy-acetylene torch?
    A. Aluminum
    B. Copper
    C. Chromium
    D. All of the above
    E. None of the above

WLD-K2

Identify the Safety Hazards

Self-Assessment No. 3 Answer Key

1.	c	11.	d
2.	b	12.	d
3.	c	13.	c
4.	b	14.	c
5.	c	15.	a
6.	b	16.	a
7.	d	17.	a
8.	a	18.	a
9.	d	19.	c
10.	b	20.	e

WELDER SERIES

MASTER Technical Module No. WLD-K03

SUBJECT: WELDING TECHNICIAN TIME: 5 HOURS

- **DUTY:** **OXYACETYLENE CUTTING AND WELDING**
- **TASK:** Describe Preventive and/or Protective Measures

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify the protective clothing and equipment used by welders;

B. Explain the purpose and use of personal protective equipment;

C. Identify the safety precautions such as the importance of locating gas lines and checking for leaks before operating equipment; and.

D. Demonstrate proper body position, protective measures involving positioning the body in safe relationship to the work and the torch, and layout of the work with clamps and fixtures.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on Personal Protective Equipment and accident prevention procedures
Transparencies will be used to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video Materials
Classroom handouts consisting of student worksheets and personal safety checklists
Safety and protective equipment
Students receive personal copy of ***Keller's Official Safety Handbook***, Latest Edition
Personal protective equipment
Oxyfuel welding equipment
Oxygen and fuel gas cylinders
Oxygen and fuel gas regulators
Torch handles
Welding and cutting tips
Cutting torch assemblies
Lighters
Selection of filler metals and oxyfuel welding rod
Selection of base metals for welding and cutting
Welding shop tools
MASTER Handout (WLD-K3-HO)
MASTER Laboratory Aid (WLD-K3-LA)

MASTER Laboratory Worksheet No. 1 (WLD-K3-LW1)
MASTER Laboratory Worksheet No. 2 (WLD-K3-LW2)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Keller's Official OSHA Safety Handbook, T.J Keller and Associates, Inc., ISBN 1-877798-21-5, Latest Edition
Operator's Manual for Oxyfuel Gas Cutting, ANSI/AWS C4.1G, Latest Edition
Welding Handbook, Volume One, Welding Technology WHB-1.8, Latest Edition
Specification for Qualification and Certification for Entry Level Welders, AWS QC10, Latest Edition
Guide for the Training and Qualifications of Welding Personnel Entry Level Welder, AWS EG2.0-95, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses.

WLD-K1	"Identify and Describe the Function of Each Piece of Equipment"
WLD-K2	"Identify the Safety Hazards"

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need for preventive and protective measures
- A class demonstration of the use of personal protective equipment
- A discussion of training activities resulting in an increase of skill and knowledge leading to certification in related program areas.

PRESENTATION OUTLINE:

Instruction Topics:

A. Purpose of wearing personal protective equipment
B. Identify potential safety hazards for all items of equipment
C. Describe protective and accident preventive measures
D. Illustrate the function of personal protective equipment (Hard Hat, Required Lens Shade, Safety Glasses, Safety Shoes, Hearing Protection Devices, and Respiratory Protection Equipment)
E. Understand the U.S. Dept. of Labor's Occupational Safety and Health Administration's Hazard Communication Standard (HazCom)

Student Activities:

A. Select and demonstrate proper use of personal protective equipment, to include eye protection with required shade of lens, hearing protection, radiation and heat protection methods, and respiratory protection
B. Practice safe methods for lighting, safe use of ladders and scaffolds
C. Practice safe methods for electrical hazards and protection against shock
D. Review HazCom Standards and locate Material Safety Data Sheets
E. Practice the use of respiratory equipment

PRACTICAL APPLICATION:

The student will set-up practice equipment in a safe and cautious manner, wearing personal protective equipment. Student will practice the use of respiratory equipment, all safety protection equipment, and use of welder's hand tools and power tools.

EVALUATION AND/OR VERIFICATION:

Examinations will be given at the end of this section to determine student progress. Students will practice the use of personal protective equipment and safe operational procedures for instructor evaluation.

SUMMARY:

Students need to be able to demonstrate the proper use of personal protective equipment, followed by assessment of safety hazards using HazCom Standards and Material Safety Data Sheets.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-K4) dealing with listing the welding variables and describe their effects on weld quality

WLD-K3-HO
Describe Preventive and/or Protective Measures
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify the protective clothing and equipment used by welders;
B. Explain the purpose and use of personal protective equipment;
C. Identify the safety precautions such as the importance of locating gas lines and checking for leaks before operating equipment; and.
D. Demonstrate proper body position, protective measures involving positioning the body in safe relationship to the work and the torch, and layout of the work with clamps and fixtures.

PRESENTATION OUTLINE:

Instruction Topics:

A. Purpose of wearing personal protective equipment
B. Identify potential safety hazards for all items of equipment
C. Describe protective and accident preventive measures
D. Illustrate the function of personal protective equipment (Hard Hat, Required Lens Shade, Safety Glasses, Safety Shoes, Hearing Protection Devices, and Respiratory Protection Equipment)
E. Understand the U.S. Dept. of Labor's Occupational Safety and Health Administration's Hazard Communication Standard (HazCom)

Student Activities:

A. Select and demonstrate proper use of personal protective equipment, to include eye protection with required shade of lens, hearing protection, radiation and heat protection methods, and respiratory protection
B. Practice safe methods for lighting, safe use of ladders and scaffolds
C. Practice safe methods for electrical hazards and protection against shock
D. Review HazCom Standards and locate Material Safety Data Sheets
E. Practice the use of respiratory equipment

WLD-K3-LA
Describe Preventive and/or Protective Measures
Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K3-LW1
Describe Preventive and/or Protective Measures
Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?

2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?

3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?

4. What are the steps in preparing to cut with oxyacetylene?

5. What are the steps in lighting the torch?

6. What are the steps in cutting metal with the torch?

7. What are the steps in extinguishing the torch?

8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
   a. Use goggles or shield with a number five shade.
   b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
   c. When lighting the torch, direct the torch away from yourself and other personnel.
   d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
   e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
   f. Never cut on containers that have contained flammable or toxic substances.
   g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
   h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

- i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
- j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
- k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
    - a. Keep acetylene operating pressures at or below 15 psi.
    - b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
    - c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
    - d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
    - e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
    - f. Do not use pipe-fitting compounds or thread lubricants for making connections.
    - g. Never use a cylinder that is leaking.
    - h. Store and transport cylinders in the upright position.
    - i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
    - j. Never tamper with fusible plugs or other safety devices on cylinders.
    - k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
    - l. Never use any cylinder, full or empty, as a roller or support.
    - m. Never use oxygen as though it were compressed air.
    - n. Do not handle oxygen cylinders on the same platform with oil.
    - o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
    - p. Store oxygen cylinders separately from fuel gas cylinders.
    - q. Always keep empty cylinders separate from full cylinders.
    - r. Mark all empty cylinders as such after use.
    - s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
    - t. Never bring any arc or flame close to or directly into contact with a cylinder.
    - u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
   a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
   b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
   c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
   d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
   a. Obtain the proper size cutting tip.
      (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
      (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
   b. Screw the cutting torch head in place, hand-tight only.
   c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
   d. Attach the regulators, hoses, torch, and correct-sized torch tip.
   e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
   f. Make sure all cutting torch valves are initially closed.
   g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
   h. Open the acetylene torch valve. Turn the acetylene torch valve off.

   - i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
   - j. Turn the acetylene torch valve off.
   - k. Turn both oxygen torch valves on.
   - l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
   - m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   - a. Put on gloves.
   - b. Put on welding goggles.
   - c. Open the torch acetylene valve one-half turn.
   - d. Immediately light the torch with a *friction lighter only*.
   - e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   - f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
     - (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
     - (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   - a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
     - (1) Cutting tip size.
     - (2) Oxygen operating pressure.
     - (3) Acetylene operating pressure.
     - (4) Preheat flame type.
     - (5) Size of preheat flame
   - b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
   - c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
   - d. Select the correct torch angle.
     - (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
     - (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

        (3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

    e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed,* the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)
    f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
    a. Close the torch acetylene valve, thus extinguishing the flame.
    b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
    a. Close the oxygen cylinder valve.
    b. Close the acetylene cylinder valve.
    c. Open the torch acetylene valve and bleed the acetylene from the line.
    d. Close the torch acetylene valve.
    e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
    f. Open the torch oxygen valve and bleed the oxygen from the line.
    g. Close the torch oxygen valve.
    h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K3-LW2
Describe Preventive and/or Protective Measures
Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

Name: ______________________________ Date: ___________________________

WLD-K3
Describe Preventive and/or Protective Measures
Self-Assessment No. 1

Circle the best answer.

1. Which of the following can be used to ignite an oxyacetylene torch?
   a. Matches
   b. A cigarette lighter
   c. A spark or friction lighter
   d. Any of the above
   e. None of the above

2. Technician A says that they can cut into an old gasoline can with the torch. Technician B says that containers of flammable or toxic substances should never be cut with a torch. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

3. If adequate ventilation is unavailable, the technician should:
   a. Cut the metal anyway; ventilation is not important.
   b. Cut the metal while wearing a respirator.
   c. Cut the metal while wearing a heavy-duty dust mask.
   d. Refuse to make the cut.

4. Acetylene operating pressures must be kept at or below:
   a. 5 psi.
   b. 15 psi.
   c. 25 psi.
   d. Acetylene operating pressures are immaterial.

5. Acetylene hoses are __________; acetylene fittings are __________.
   a. Red - left-handed
   b. Blue - left-handed
   c. Red - right-handed
   d. Blue - left-handed
   e. None of the above

6. All cylinders should be secured except when:
   a. Transporting them.
   b. Storing them.
   c. Using them.
   d. Always secure cylinders with chains or in permanent racks.
   e. Securing cylinders is unnecessary.

7. Technician A says that oxygen cylinders should be stored well away from fuel gas cylinders. Technician B says that separate storage is unnecessary. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

8. The maximum safe withdrawal rate for acetylene cylinders is:
   a. One fourth of current content per hour.
   b. One fifth of current content per hour.
   c. One seventh of current content per hour.
   d. One tenth of current content per hour.
   e. None of the above

9. Technician A says that only oxygen-specific regulators can be used on oxygen cylinders. Technician B says that it is acceptable to use oxygen regulators on other gas cylinders. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

10. Which of the following can be cut with an oxyacetylene torch?
   a. Aluminum
   b. Copper
   c. Chromium
   d. All of the above
   e. None of the above

11. Technician A says that the acetylene cylinder's valve should be opened all the way. Technician B says that the oxygen cylinder's valve should be opened no more than one full turn. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

12. Before attaching the regulators to the cylinder valves:
    a. Clean the nipples with acetone.
    b. Crack the valves to blow out any dirt.
    c. Lubricate the threads with oil.
    d. All of the above
    e. None of the above

13. Technician A says that they must reduce the acetylene flow until the flame just starts to produce black smoke around its edges. Technician B says that the acetylene flow must then be increased until the smoke disappears. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

14. Dirty orifices on the cutting tip can produce:
    a. Wide kerfs.
    b. Adherent slag.
    c. Rough cut appearance.
    d. All of the above.
    e. None of the above

15. Technician A says that, for cutting holes, the torch must be held parallel to the base metal throughout the cut. Technician B says that square cuts require the torch to be held at 45° to the base metal. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

16. Lag lines are the result of
    a. Correct travel speed.
    b. Too great a travel speed.
    c. Too slow a travel speed.
    d. Incorrect torch angle.
    e. None of the above

17. When extinguishing the torch, Technician A says that the acetylene torch valve should be closed first. Technician B says that the oxygen torch valve should be closed first. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

18. Good oxy-fuel cuts require an oxygen purity of at least:
   - a. 99.5%.
   - b. 95.9%.
   - c. 59.9%.
   - d. None of the above.

19. Both acetylene and oxygen lines should be __________ when closing down the work station.
   - a. Removed
   - b. Cleaned with acetone
   - c. Bled free of gas or fuel
   - d. All of the above
   - e. None of the above

20. Technician A says that since B is left-handed, B should cut from left to right. Technician B says that the pre-heat flame should still be from 1/6" to 1/2" from the base metal, regardless of the direction of travel. Who is correct?
   - a. Technician A only
   - b. Technician B only
   - c. Both Technicians A and B
   - d. Neither Technician A nor B

WLD-K3
Describe Preventive and/or Protective Measures
Self-Assessment No. 1 Answer Key

1. c
2. b
3. b
4. b
5. a
6. d
7. a
8. c
9. a
10. e
11. d
12. b
13. c
14. d
15. d
16. b
17. a
18. a
19. c
20. c

Name: ______________________________ Date: ________________________

WLD-K3
Describe Preventive and/or Protective Measures
Self-Assessment No. 2

1. What is the major difference between a brazed joint and a welded joint?

2. What two conditions determines whether the joint is brazed or welded?

3. How does flux act as a guide to the temperature of the joint?

4. What is the color of the plate when it is at the proper temperature for welding?

5. Is brazing stronger than fusion welding?

6. For silver soldering: what is a 3x flame?

7. What alloys are contained in typical silver soldering?

8. How can material be prepared for silver soldering?

9. **Is it possible to make fillets when using silver soldering alloys?**

____

____

____

WLD-K4

WELDER SERIES

MASTER Technical Module No. WLD-K04

SUBJECT: WELDING TECHNICIAN TIME: 12 HOURS

- **DUTY:** **OXYACETYLENE CUTTING AND WELDING**
- **TASK:** List the Welding Variables and Describe Their Effects on Weld Quality

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to the visual examination of welds;
B. Perform visual examination of welds;
C. Discuss common weld discontinuities;
D. Explain the impact of welding variables on oxyacetylene processes; and,
E. Demonstrate brazing and soldering techniques.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on oxyacetylene welding variables and operational procedures
Transparencies will be used to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video Material
Classroom handouts consisting of student worksheets demonstrating proper beading technique and welding variables
Hobart OAW wall chart
Personal protective equipment
Oxyfuel welding equipment
Oxygen and fuel gas cylinders
Oxygen and fuel gas regulators
Torch handles
Welding and cutting tips
Cutting torch assemblies
Lighters
Selection of filler metals and oxyfuel welding rod
Selection of base metals for welding and cutting
Welding shop tools
MASTER Handout (WLD-K4-HO)
MASTER Laboratory Aid (WLD-K4-LA)
MASTER Laboratory Worksheet No. 1 (WLD-K4-LW1)

MASTER Laboratory Worksheet No. 2 (WLD-K4-LW2)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Keller's Official OSHA Safety Handbook, T.J Keller and Associates, Inc., ISBN 1-877798-21-5, Latest Edition
Operator's Manual for Oxyfuel Gas Cutting, ANSI/AWS C4.1G, Latest Edition
Welding Handbook, Volume One, Welding Technology WHB-1.8, Latest Edition
Specification for Qualification and Certification for Entry Level Welders, AWS QC10, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required college prerequisite courses.

WLD-K1	"Identify and Describe the Function of Each Piece of Equipment"
WLD-K2	"Identify the Safety Hazards"
WLD-K3	"Describe Preventive and/or Protective Measures"

INTRODUCTION:

The Course Introduction will Include:

- An overview of weld variables and their effects on weld quality

- A class demonstration of welding variables and their effects on weld quality
- A discussion on professional development activities that will lead to certification in related program areas

---

PRESENTATION OUTLINE:

Instruction Topics:

A. Continue to illustrate the function of Oxyacetylene equipment
B. Demonstrate discontinuities and their effects on weld quality
C. Illustrate welding variables and how procedures can maintain weld quality
D. Illustrate proper techniques of applying welds or beads in various positions
E. Illustrate variables associated with cutting
F. Demonstrate brazing and soldering of various metals in various positions

Student Activities:

A. Identify weld discontinuities
B. Remove discontinuities from cut area using grinders and files
C. Remove oxidation for welding
D. Demonstrate proper cleaning techniques
E. Oxyacetylene weld practice pieces
F. Explain weld variables and use of filler metal for each welding example
G. Evaluate the process followed for each example
H. Braze and silver solder mild steel in various positions

PRACTICAL APPLICATION:

Utilizing all safety measures and protective equipment, the student will set-up oxyacetylene equipment. When welding various metals the student will chart the welding variables and understand their effects on weld quality.

EVALUATION AND/OR VERIFICATION:

Two examinations will be given in this module to determine student progress. Practical exercises will be evaluated by student and instructor.

SUMMARY:

The class will discuss filler metal compatibility with metals using the oxyacetylene welding process. The methods to prevent or reduce weld related distortion will be discussed and demonstrated in laboratory exercises. Proper methods of applying beads and a complete understanding of welding variables for oxyacetylene welding will be taught and emphasized with practical exercises.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-K5) dealing with describing the AWS oxyfuel gas welding rod classification system.

WLD-K4-HO
List the Welding Variables and Describe Their Effects on Weld Quality
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to the visual examination of welds;
B. Perform visual examination of welds;
C. Discuss common weld discontinuities;
D. Explain the impact of welding variables on oxyacetylene processes; and,
E. Demonstrate brazing and soldering techniques.

MODULE OUTLINE:

Instruction Topics:

A. Continue to illustrate the function of Oxyacetylene equipment
B. Demonstrate discontinuities and their effects on weld quality
C. Illustrate welding variables and how procedures can maintain weld quality
D. Illustrate proper techniques of applying welds or beads in various positions
E. Illustrate variables associated with cutting
F. Demonstrate brazing and soldering of various metals in various positions

Student Activities:

A. Identify weld discontinuities
B. Remove discontinuities from cut area using grinders and files
C. Remove oxidation for welding
D. Demonstrate proper cleaning techniques
E. Oxyacetylene weld practice pieces
F. Explain weld variables and use of filler metal for each welding example
G. Evaluate the process followed for each example
H. Braze and silver solder mild steel in various positions

WLD-K4-LA
List the Welding Variables and Describe Their Effects on Weld Quality
Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K4-LW1
List the Welding Variables and Describe Their Effects on Weld Quality
Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?
2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?
3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?
4. What are the steps in preparing to cut with oxyacetylene?
5. What are the steps in lighting the torch?
6. What are the steps in cutting metal with the torch?
7. What are the steps in extinguishing the torch?
8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
    a. Use goggles or shield with a number five shade.
    b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
    c. When lighting the torch, direct the torch away from yourself and other personnel.
    d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
    e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
    f. Never cut on containers that have contained flammable or toxic substances.
    g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
    h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

    i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
    j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
    k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
    a. Keep acetylene operating pressures at or below 15 psi.
    b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
    c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
    d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
    e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
    f. Do not use pipe-fitting compounds or thread lubricants for making connections.
    g. Never use a cylinder that is leaking.
    h. Store and transport cylinders in the upright position.
    i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
    j. Never tamper with fusible plugs or other safety devices on cylinders.
    k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
    l. Never use any cylinder, full or empty, as a roller or support.
    m. Never use oxygen as though it were compressed air.
    n. Do not handle oxygen cylinders on the same platform with oil.
    o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
    p. Store oxygen cylinders separately from fuel gas cylinders.
    q. Always keep empty cylinders separate from full cylinders.
    r. Mark all empty cylinders as such after use.
    s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
    t. Never bring any arc or flame close to or directly into contact with a cylinder.
    u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
    a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
    b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
    c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
    d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4 Steps in preparing to cut with oxyacetylene:
    a. Obtain the proper size cutting tip.
        (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
        (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
    b. Screw the cutting torch head in place, hand-tight only.
    c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
    d. Attach the regulators, hoses, torch, and correct-sized torch tip.
    e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
    f. Make sure all cutting torch valves are initially closed.
    g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
    h. Open the acetylene torch valve. Turn the acetylene torch valve off.

    i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
    j. Turn the acetylene torch valve off.
    k. Turn both oxygen torch valves on.
    l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
    m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
    a. Put on gloves.
    b. Put on welding goggles.
    c. Open the torch acetylene valve one-half turn.
    d. Immediately light the torch with a *friction lighter only*.
    e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
    f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
        (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
        (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, here will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
    a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
        (1) Cutting tip size.
        (2) Oxygen operating pressure.
        (3) Acetylene operating pressure.
        (4) Preheat flame type.
        (5) Size of preheat flame
    b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
    c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
    d. Select the correct torch angle.
        (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
        (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

        (3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

    e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed,* the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)

    f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
    a. Close the torch acetylene valve, thus extinguishing the flame.
    b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
    a. Close the oxygen cylinder valve.
    b. Close the acetylene cylinder valve.
    c. Open the torch acetylene valve and bleed the acetylene from the line.
    d. Close the torch acetylene valve.
    e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
    f. Open the torch oxygen valve and bleed the oxygen from the line.
    g. Close the torch oxygen valve.
    h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K4-LW2

List the Welding Variables and Describe Their Effects on Weld Quality

Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

Name: ______________________________ Date: ____________________________

WLD-K4
List the Welding Variables and Describe Their Effects on Weld Quality
Self-Assessment No. 1

Circle the best answer.

1. Which of the following can be used to ignite an oxyacetylene torch?
   a. Matches
   b. A cigarette lighter
   c. A spark or friction lighter
   d. Any of the above
   e. None of the above

2. Technician A says that they can cut into an old gasoline can with the torch. Technician B says that containers of flammable or toxic substances should never be cut with a torch. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

3. If adequate ventilation is unavailable, the technician should:
   a. Cut the metal anyway; ventilation is not important.
   b. Cut the metal while wearing a respirator.
   c. Cut the metal while wearing a heavy-duty dust mask.
   d. Refuse to make the cut.

4. Acetylene operating pressures must be kept at or below:
   a. 5 psi.
   b. 15 psi.
   c. 25 psi.
   d. Acetylene operating pressures are immaterial.

5. Acetylene hoses are __________; acetylene fittings are __________.
   a. Red - left-handed
   b. Blue - left-handed
   c. Red - right-handed
   d. Blue - left-handed
   e. None of the above

6. All cylinders should be secured except when:
    a. Transporting them.
    b. Storing them.
    c. Using them.
    d. Always secure cylinders with chains or in permanent racks.
    e. Securing cylinders is unnecessary.

7. Technician A says that oxygen cylinders should be stored well away from fuel gas cylinders. Technician B says that separate storage is unnecessary. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

8. The maximum safe withdrawal rate for acetylene cylinders is:
    a. One fourth of current content per hour.
    b. One fifth of current content per hour.
    c. One seventh of current content per hour.
    d. One tenth of current content per hour.
    e. None of the above

9. Technician A says that only oxygen-specific regulators can be used on oxygen cylinders. Technician B says that it is acceptable to use oxygen regulators on other gas cylinders. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

10. Which of the following can be cut with an oxyacetylene torch?
    a. Aluminum
    b. Copper
    c. Chromium
    d. All of the above
    e. None of the above

11. Technician A says that the acetylene cylinder's valve should be opened all the way. Technician B says that the oxygen cylinder's valve should be opened no more than one full turn. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

12. Before attaching the regulators to the cylinder valves:
  a. Clean the nipples with acetone.
  b. Crack the valves to blow out any dirt.
  c. Lubricate the threads with oil.
  d. All of the above
  e. None of the above

13. Technician A says that they must reduce the acetylene flow until the flame just starts to produce black smoke around its edges. Technician B says that the acetylene flow must then be increased until the smoke disappears. Who is correct?
  a. Technician A only
  b. Technician B only
  c. Both Technicians A and B
  d. Neither Technician A nor B

14. Dirty orifices on the cutting tip can produce:
  a. Wide kerfs.
  b. Adherent slag.
  c. Rough cut appearance.
  d. All of the above.
  e. None of the above

15. Technician A says that, for cutting holes, the torch must be held parallel to the base metal throughout the cut. Technician B says that square cuts require the torch to be held at 45° to the base metal. Who is correct?
  a. Technician A only
  b. Technician B only
  c. Both Technicians A and B
  d. Neither Technician A nor B

16. Lag lines are the result of
  a. Correct travel speed.
  b. Too great a travel speed.
  c. Too slow a travel speed.
  d. Incorrect torch angle.
  e. None of the above

17. When extinguishing the torch, Technician A says that the acetylene torch valve should be closed first. Technician B says that the oxygen torch valve should be closed first. Who is correct?
  a. Technician A only
  b. Technician B only
  c. Both Technicians A and B
  d. Neither Technician A nor B

18. Good oxy-fuel cuts require an oxygen purity of at least:
   a. 99.5%.
   b. 95.9%.
   c. 59.9%.
   d. None of the above.

19. Both acetylene and oxygen lines should be __________ when closing down the work station.
   a. Removed
   b. Cleaned with acetone
   c. Bled free of gas or fuel
   d. All of the above
   e. None of the above

20. Technician A says that since B is left-handed, B should cut from left to right. Technician B says that the pre-heat flame should still be from 1/6" to 1/2" from the base metal, regardless of the direction of travel. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

WLD-K4

List the Welding Variables and Describe Their Effects on Weld Quality

Self-Assessment No. 1 Answer Key

1.	c	11.	d
2.	b	12.	b
3.	b	13.	c
4.	b	14.	d
5.	a	15.	d
6.	d	16.	b
7.	a	17.	a
8.	c	18.	a
9.	a	19.	c
10.	e	20.	c

Name: ______________________ Date: ____________________

WLD-K4

List the Welding Variables and Describe Their Effects on Weld Quality

Self-Assessment No. 2

1. What is the major difference between a brazed joint and a welded joint?

2. What two conditions determines whether the joint is brazed or welded?

3. How does flux act as a guide to the temperature of the joint?

4. What is the color of the plate when it is at the proper temperature for welding?

5. Is brazing stronger than fusion welding?

6. For silver soldering: what is a 3x flame?

7. What alloys are contained in typical silver soldering?

8. How can material be prepared for silver soldering?

9. **Is it possible to make fillets when using silver soldering alloys?**

____

____

____

WELDER SERIES

MASTER Technical Module No. WLD-K05

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **OXYACETYLENE CUTTING AND WELDING**
- **TASK:** Describe the AWS Oxyfuel Gas Welding Rod Classification System

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Classify filler metal for oxy-fuel gas welding;
B. Identify parent metal compatibility with filler metal; and,
C. Select welding tips required for the process.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on metal alloy charts, AWS welding rod classification, and selection of welding tips
Transparencies will be used to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video Material
Classroom handouts consisting of student worksheets, metal compatibility, filler metal, and alloy charts
Hobart OAW wall chart
Personal protective equipment
Oxyfuel welding equipment
Oxygen and fuel gas cylinders
Oxygen and fuel gas regulators
Torch handles
Welding and cutting tips
Cutting torch assemblies
Lighters
Selection of filler metals and oxyfuel welding rod
Selection of base metals for welding and cutting
Welding shop tools
MASTER Handout (WLD-K5-HO)
MASTER Laboratory Aid (WLD-K5-LA)
MASTER Laboratory Worksheet No. 1 (WLD-K5-LW1)
MASTER Laboratory Worksheet No. 2 (WLD-K5-LW2)

MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Keller's Official OSHA Safety Handbook, T.J Keller and Associates, Inc., ISBN 1-877798-21-5, Latest Edition
Operator's Manual for Oxyfuel Gas Cutting, ANSI/AWS C4.1G, Latest Edition
Welding Handbook, Volume One, Welding Technology WHB-1.8, Latest Edition
Specification for Qualification and Certification for Entry Level Welders, AWS QC10, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses.

WLD-K1	"Identify and Describe the Function of Each Piece of Equipment"
WLD-K2	"Identify the Safety Hazards"
WLD-K3	"Describe Preventive and/or Protective Measures"
WLD-K4	"List the Welding Variables and Describe Their Effects on Weld Quality"

INTRODUCTION:

The Course Introduction will Include:

- An overview of the metallurgy, metal alloys and the purpose of filler metal.
- A class demonstration of the AWS Oxyacetylene Rod Classification System
- A discussion on methods of study resulting in an increase of skill and knowledge in metallurgy applications, use of filler metals, and AWS welding rod classifications

---

PRESENTATION OUTLINE:

Instruction Topics:

A. Welding Rod defined as: "a filler metal used for welding or brazing which does not conduct the electric current."
B. Welding rod types, lengths and diameters
C. Common welding rods: mild steel, cast iron, stainless steel, braze welding alloys, aluminum (drawn, extended, cast)
D. Mil-Specifications and AWS Specification numbers
E. Illustrate AWS Oxyacetylene Rod Classification System
F. Factors in selecting welding tips for varied work and thickness of metal

Student Activities:

A. Selection of filler metal based upon compatibility charts and alloy charts
B. Selection of welding tips to perform the work
C. Perform welds using selected filler metals
D. Testing of weld for discontinuities and strength

PRACTICAL APPLICATION:

When welding various metals, the student will select the compatible filler metal used for metals to be welded in the selected process. The student will learn to use the AWS Welding Rod Classification System, and select appropriate welding tips to perform the work.

EVALUATION AND/OR VERIFICATION:

Written examinations will be given during this module to determine student progress. Welding exercises will be performed using selected filler metals and welding tips. Welds will be inspected and tested by students and instructor.

SUMMARY:

Emphasis will be on the selection of filler metal, welding (filler) rod and welding tips for quality welds and strength of materials. In oxyfuel welding, welding (filler) rod is applied to help build up and strengthen the weld.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-K6) dealing with describing techniques for preventing or reducing welding related distortion.

WLD-K5-HO

Describe the AWS Oxyfuel Gas Welding Rod Classification System

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Classify filler metal for oxy-fuel gas welding;

B. Identify parent metal compatibility with filler metal; and,

C. Select welding tips required for the process.

PRESENTATION OUTLINE:

Instruction Topics:

A. Welding Rod defined as: "a filler metal used for welding or brazing which does not conduct the electric current."

B. Welding rod types, lengths and diameters

C. Common welding rods: mild steel, cast iron, stainless steel, braze welding alloys, aluminum (drawn, extended, cast)

D. Mil-Specifications and AWS Specification numbers

E. Illustrate AWS Oxyacetylene Rod Classification System

F. Factors in selecting welding tips for varied work and thickness of metal

Student Activities:

A. Selection of filler metal based upon compatibility charts and alloy charts

B. Selection of welding tips to perform the work

C. Perform welds using selected filler metals

D. Testing of weld for discontinuities and strength

WLD-K5-LA

Describe the AWS Oxyfuel Gas Welding Rod Classification System

Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K5-LW1

Describe the AWS Oxyfuel Gas Welding Rod Classification System

Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?

2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?

3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?

4. What are the steps in preparing to cut with oxyacetylene?

5. What are the steps in lighting the torch?

6. What are the steps in cutting metal with the torch?

7. What are the steps in extinguishing the torch?

8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
   a. Use goggles or shield with a number five shade.
   b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
   c. When lighting the torch, direct the torch away from yourself and other personnel.
   d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
   e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
   f. Never cut on containers that have contained flammable or toxic substances.
   g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
   h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

- i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
- j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
- k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
   - a. Keep acetylene operating pressures at or below 15 psi.
   - b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   - c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   - d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   - e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   - f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   - g. Never use a cylinder that is leaking.
   - h. Store and transport cylinders in the upright position.
   - i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   - j. Never tamper with fusible plugs or other safety devices on cylinders.
   - k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   - l. Never use any cylinder, full or empty, as a roller or support.
   - m. Never use oxygen as though it were compressed air.
   - n. Do not handle oxygen cylinders on the same platform with oil.
   - o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
   - p. Store oxygen cylinders separately from fuel gas cylinders.
   - q. Always keep empty cylinders separate from full cylinders.
   - r. Mark all empty cylinders as such after use.
   - s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   - t. Never bring any arc or flame close to or directly into contact with a cylinder.
   - u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
    a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
    b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
    c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
    d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4 Steps in preparing to cut with oxyacetylene:
    a Obtain the proper size cutting tip.
        (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
        (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
    b. Screw the cutting torch head in place, hand-tight only.
    c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
    d. Attach the regulators, hoses, torch, and correct-sized torch tip.
    e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
    f. Make sure all cutting torch valves are initially closed.
    g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
    h. Open the acetylene torch valve. Turn the acetylene torch valve off.

    - i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
    - j. Turn the acetylene torch valve off.
    - k. Turn both oxygen torch valves on.
    - l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
    - m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
    - a. Put on gloves.
    - b. Put on welding goggles.
    - c. Open the torch acetylene valve one-half turn.
    - d. Immediately light the torch with a *friction lighter only.*
    - e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
    - f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
        - (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
        - (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
    - a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
        - (1) Cutting tip size.
        - (2) Oxygen operating pressure.
        - (3) Acetylene operating pressure.
        - (4) Preheat flame type.
        - (5) Size of preheat flame
    - b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
    - c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
    - d. Select the correct torch angle.
        - (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
        - (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

    (3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

  e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed,* the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)
  f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
  a. Close the torch acetylene valve, thus extinguishing the flame.
  b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
  a. Close the oxygen cylinder valve.
  b. Close the acetylene cylinder valve.
  c. Open the torch acetylene valve and bleed the acetylene from the line.
  d. Close the torch acetylene valve.
  e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
  f. Open the torch oxygen valve and bleed the oxygen from the line.
  g. Close the torch oxygen valve.
  h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K5-LW2
Describe the AWS Oxyfuel Gas Welding Rod Classification System
Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

Name: ______________________________ Date: ____________________________

WLD-K5
Describe the AWS Oxyfuel Gas Welding Rod Classification System
Self-Assessment No. 1

Circle the best answer.

1. Which of the following can be used to ignite an oxyacetylene torch?
   a. Matches
   b. A cigarette lighter
   c. A spark or friction lighter
   d. Any of the above
   e. None of the above

2. Technician A says that they can cut into an old gasoline can with the torch. Technician B says that containers of flammable or toxic substances should never be cut with a torch. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

3. If adequate ventilation is unavailable, the technician should:
   a. Cut the metal anyway; ventilation is not important.
   b. Cut the metal while wearing a respirator.
   c. Cut the metal while wearing a heavy-duty dust mask.
   d. Refuse to make the cut.

4. Acetylene operating pressures must be kept at or below:
   a. 5 psi.
   b. 15 psi.
   c. 25 psi.
   d. Acetylene operating pressures are immaterial.

5. Acetylene hoses are __________; acetylene fittings are __________.
   a. Red - left-handed
   b. Blue - left-handed
   c. Red - right-handed
   d. Blue - left-handed
   e. None of the above

6. All cylinders should be secured except when:
   a. Transporting them.
   b. Storing them.
   c. Using them.
   d. Always secure cylinders with chains or in permanent racks.
   e. Securing cylinders is unnecessary.

7. Technician A says that oxygen cylinders should be stored well away from fuel gas cylinders. Technician B says that separate storage is unnecessary. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

8. The maximum safe withdrawal rate for acetylene cylinders is:
   a. One fourth of current content per hour.
   b. One fifth of current content per hour.
   c. One seventh of current content per hour.
   d. One tenth of current content per hour.
   e. None of the above

9. Technician A says that only oxygen-specific regulators can be used on oxygen cylinders. Technician B says that it is acceptable to use oxygen regulators on other gas cylinders. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

10. Which of the following can be cut with an oxyacetylene torch?
    a. Aluminum
    b. Copper
    c. Chromium
    d. All of the above
    e. None of the above

11. Technician A says that the acetylene cylinder's valve should be opened all the way. Technician B says that the oxygen cylinder's valve should be opened no more than one full turn. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

12. Before attaching the regulators to the cylinder valves:
    a. Clean the nipples with acetone.
    b. Crack the valves to blow out any dirt.
    c. Lubricate the threads with oil.
    d. All of the above
    e. None of the above

13. Technician A says that they must reduce the acetylene flow until the flame just starts to produce black smoke around its edges. Technician B says that the acetylene flow must then be increased until the smoke disappears. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

14. Dirty orifices on the cutting tip can produce:
    a. Wide kerfs.
    b. Adherent slag.
    c. Rough cut appearance.
    d. All of the above.
    e. None of the above

15. Technician A says that, for cutting holes, the torch must be held parallel to the base metal throughout the cut. Technician B says that square cuts require the torch to be held at 45° to the base metal. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

16. Lag lines are the result of
    a. Correct travel speed.
    b. Too great a travel speed.
    c. Too slow a travel speed.
    d. Incorrect torch angle.
    e. None of the above

17. When extinguishing the torch, Technician A says that the acetylene torch valve should be closed first. Technician B says that the oxygen torch valve should be closed first. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

18. Good oxy-fuel cuts require an oxygen purity of at least:
   a. 99.5%.
   b. 95.9%.
   c. 59.9%.
   d. None of the above.

19. Both acetylene and oxygen lines should be __________ when closing down the work station.
   a. Removed
   b. Cleaned with acetone
   c. Bled free of gas or fuel
   d. All of the above
   e. None of the above

20. Technician A says that since B is left-handed, B should cut from left to right. Technician B says that the pre-heat flame should still be from 1/6" to 1/2" from the base metal, regardless of the direction of travel. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

WLD-K5
Describe the AWS Oxyfuel Gas Welding Rod Classification System
Self-Assessment No. 1 Answer Key

1.	c
2.	b
3.	b
4.	b
5.	a
6.	d
7.	a
8.	c
9.	a
10.	e
11.	d
12.	b
13.	c
14.	d
15.	d
16.	b
17.	a
18.	a
19.	c
20.	c

Name: ______________________________ Date: ________________________

WLD-K5
Describe the AWS Oxyfuel Gas Welding Rod Classification System
Self-Assessment No. 2

1. What is the major difference between a brazed joint and a welded joint?

____
____
____

2. What two conditions determines whether the joint is brazed or welded?

____
____
____

3. How does flux act as a guide to the temperature of the joint?

____
____
____

4. What is the color of the plate when it is at the proper temperature for welding?

____
____
____

5. Is brazing stronger than fusion welding?

____
____
____

6. For silver soldering: what is a 3x flame?

____
____
____

7. What alloys are contained in typical silver soldering?

____
____
____

8. How can material be prepared for silver soldering?

____
____
____

9. Is it possible to make fillets when using silver soldering alloys?

WELDER SERIES

MASTER Technical Module No. WLD-K06

SUBJECT: WELDING TECHNICIAN **TIME: 8 HOURS**

- **DUTY:** OXYACETYLENE CUTTING AND WELDING
- **TASK:** Describe Techniques for Preventing or Reducing Welding Related Distortion

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand stresses caused by welding processes;
B. Use fixtures and clamps to minimize distortion;
C. Understand metal properties exhibited by heating and cooling;
D. Relieve internal stresses by heat treatment; and,
E. Prepare trainee for the related sections of ANSI/AWS C4.2, Operator's Manual for Oxyfuel Gas Cutting and AWS C4.1, Criteria for Describing Oxygen-Cut Surfaces.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on methods to reduce distortion caused by welding heat and stress
Transparencies will be used to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video Material
Classroom handouts consisting of student worksheets and alloy charts
Hobart OAW wall chart
Personal protective equipment
Oxyfuel welding equipment
Oxygen and fuel gas cylinders
Oxygen and fuel gas regulators
Torch handles
Welding and cutting tips
Cutting torch assemblies
Lighters
Selection of filler metals and oxyfuel welding rod
Selection of base metals for welding and cutting
Welding shop tools
MASTER Handout (WLD-K6-HO)
MASTER Laboratory Aid (WLD-K6-LA)

MASTER Laboratory Worksheet No. 1 (WLD-K6-LW1)
MASTER Laboratory Worksheet No. 2 (WLD-K6-LW2)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Keller's Official OSHA Safety Handbook, T.J Keller and Associates, Inc., ISBN 1-877798-21-5, Latest Edition
Operator's Manual for Oxyfuel Gas Cutting, ANSI/AWS C4.1G, Latest Edition
Welding Handbook, Volume One, Welding Technology WHB-1.8, Latest Edition
Specification for Qualification and Certification for Entry Level Welders, AWS QC10, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses.

WLD-K1	"Identify and Describe the Function of Each Piece of Equipment"
WLD-K2	"Identify the Safety Hazards"
WLD-K3	"Describe Preventive and/or Protective Measures"
WLD-K4	"List the Welding Variables and Describe Their Effects on Weld Quality"
WLD-K5	"Describe the AWS Oxyfuel Gas Welding Rod Classification System"

INTRODUCTION:

The Course Introduction will Include:

- An overview of stresses caused by welding processes
- Methods used to minimize distortion
- A discussion of metal properties exhibited by heating and cooling

PRESENTATION OUTLINE:

Instruction Topics:

A. Describe stresses caused by welding and the expansion rate of metal
B. Describe heat created by the welding process causing expansion
C. Describe contraction or shrinking caused by cooling
D. If metal does not return to original shape, explain how distortion has occurred
E. Reduce distortion by clamping parts into a fixture while welding
F. Discuss metal properties changed by heat and expansion factors
G. Demonstrate residual stresses relieved by heat treatment
H. Judge temperature by color of materials

Student Activities:

A. Perform welding experiments in heating and contraction of specific metals
B. Practice welding exercises using fixtures and clamping
C. Practice stress relief by heat treatment

PRACTICAL APPLICATION:

When welding various metals, the student will minimize distortion by using clamps and fixtures and practicing stress relief.

EVALUATION AND/OR VERIFICATION:

Written examinations will be given in this module to determine student progress. Practical exercises will be conducted with heating and contraction of metals secured by fixtures and clamps and stress relief will be performed by heat treatment.

SUMMARY:

Emphasis will be on preventing or reducing weld related distortion while maintaining weld quality.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-K7) dealing with welding mild steel sheet metal using techniques that will minimize the effects of distortion.

WLD-K6-HO
Describe Techniques for Preventing or Reducing Welding Related Distortion
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Understand stresses caused by welding processes;
B. Use fixtures and clamps to minimize distortion;
C. Understand metal properties exhibited by heating and cooling;
D. Relieve internal stresses by heat treatment; and,
E. Prepare trainee for the related sections of ANSI/AWS C4.2, Operator's Manual for Oxyfuel Gas Cutting and AWS C4.1, Criteria for Describing Oxygen-Cut Surfaces.

MODULE OUTLINE:

Instruction Topics:
A. Describe stresses caused by welding and the expansion rate of metal
B. Describe heat created by the welding process causing expansion
C. Describe contraction or shrinking caused by cooling
D. If metal does not return to original shape, explain how distortion has occurred
E. Reduce distortion by clamping parts into a fixture while welding
F. Discuss metal properties changed by heat and expansion factors
G. Demonstrate residual stresses relieved by heat treatment
H. Judge temperature by color of materials

Student Activities:
A. Perform welding experiments in heating and contraction of specific metals
B. Practice welding exercises using fixtures and clamping
C. Practice stress relief by heat treatment

Describe Techniques for Preventing or Reducing Welding Related Distortion

Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.
l. Never use any cylinder, full or empty, as a roller or support.
m. Never use oxygen as though it were compressed air.
n. Do not handle oxygen cylinders on the same platform with oil.
o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
p. Store oxygen cylinders separately from fuel gas cylinders.
q. Always keep empty cylinders separate from full cylinders.
r. Mark all empty cylinders as such after use.
s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
t. Never bring any arc or flame close to or directly into contact with a cylinder.
u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K6-LW1

Describe Techniques for Preventing or Reducing Welding Related Distortion

Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?
2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?
3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?
4. What are the steps in preparing to cut with oxyacetylene?
5. What are the steps in lighting the torch?
6. What are the steps in cutting metal with the torch?
7. What are the steps in extinguishing the torch?
8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
   a. Use goggles or shield with a number five shade.
   b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
   c. When lighting the torch, direct the torch away from yourself and other personnel
   d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
   e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
   f. Never cut on containers that have contained flammable or toxic substances.
   g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
   h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

   i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
   j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
   k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
   a. Keep acetylene operating pressures at or below 15 psi.
   b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   g. Never use a cylinder that is leaking.
   h. Store and transport cylinders in the upright position.
   i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   j. Never tamper with fusible plugs or other safety devices on cylinders.
   k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   l. Never use any cylinder, full or empty, as a roller or support.
   m. Never use oxygen as though it were compressed air.
   n. Do not handle oxygen cylinders on the same platform with oil.
   o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
   p. Store oxygen cylinders separately from fuel gas cylinders.
   q. Always keep empty cylinders separate from full cylinders.
   r. Mark all empty cylinders as such after use.
   s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   t. Never bring any arc or flame close to or directly into contact with a cylinder.
   u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
   a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
   b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
   c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
   d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
   a. Obtain the proper size cutting tip.
      (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
      (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
   b. Screw the cutting torch head in place, hand-tight only.
   c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
   d. Attach the regulators, hoses, torch, and correct-sized torch tip.
   e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
   f. Make sure all cutting torch valves are initially closed.
   g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
   h. Open the acetylene torch valve. Turn the acetylene torch valve off.

i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
j. Turn the acetylene torch valve off.
k. Turn both oxygen torch valves on.
l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   a. Put on gloves.
   b. Put on welding goggles.
   c. Open the torch acetylene valve one-half turn.
   d. Immediately light the torch with a *friction lighter only.*
   e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
      (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
      (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
      (1) Cutting tip size.
      (2) Oxygen operating pressure.
      (3) Acetylene operating pressure.
      (4) Preheat flame type.
      (5) Size of preheat flame
   b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
   c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
   d. Select the correct torch angle.
      (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
      (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

(3) For *holes*, the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the *correct travel speed*, the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed*, the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8 Steps in closing down the welding station:
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. Open the torch acetylene valve and bleed the acetylene from the line.
   d. Close the torch acetylene valve.
   e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
   f. Open the torch oxygen valve and bleed the oxygen from the line.
   g. Close the torch oxygen valve.
   h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K6-LW2

Describe Techniques for Preventing or Reducing Welding Related Distortion

Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

Name: ______________________________ Date: ___________________________

WLD-K6

Describe Techniques for Preventing or Reducing Welding Related Distortion

Self-Assessment No. 1

Circle the best answer.

1. Which of the following can be used to ignite an oxyacetylene torch?
    a. Matches
    b. A cigarette lighter
    c. A spark or friction lighter
    d. Any of the above
    e. None of the above

2. Technician A says that they can cut into an old gasoline can with the torch. Technician B says that containers of flammable or toxic substances should never be cut with a torch. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

3. If adequate ventilation is unavailable, the technician should:
    a. Cut the metal anyway; ventilation is not important.
    b. Cut the metal while wearing a respirator.
    c. Cut the metal while wearing a heavy-duty dust mask.
    d. Refuse to make the cut.

4. Acetylene operating pressures must be kept at or below:
    a. 5 psi.
    b. 15 psi.
    c. 25 psi.
    d. Acetylene operating pressures are immaterial.

5. Acetylene hoses are __________; acetylene fittings are __________.
    a. Red - left-handed
    b. Blue - left-handed
    c. Red - right-handed
    d. Blue - left-handed
    e. None of the above

6. All cylinders should be secured except when:
   a. Transporting them.
   b. Storing them.
   c. Using them.
   d. Always secure cylinders with chains or in permanent racks.
   e. Securing cylinders is unnecessary.

7. Technician A says that oxygen cylinders should be stored well away from fuel gas cylinders. Technician B says that separate storage is unnecessary. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

8. The maximum safe withdrawal rate for acetylene cylinders is:
   a. One fourth of current content per hour.
   b. One fifth of current content per hour.
   c. One seventh of current content per hour.
   d. One tenth of current content per hour.
   e. None of the above

9. Technician A says that only oxygen-specific regulators can be used on oxygen cylinders. Technician B says that it is acceptable to use oxygen regulators on other gas cylinders. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

10. Which of the following can be cut with an oxyacetylene torch?
    a. Aluminum
    b. Copper
    c. Chromium
    d. All of the above
    e. None of the above

11. Technician A says that the acetylene cylinder's valve should be opened all the way. Technician B says that the oxygen cylinder's valve should be opened no more than one full turn. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

12. Before attaching the regulators to the cylinder valves:
   a. Clean the nipples with acetone.
   b. Crack the valves to blow out any dirt.
   c. Lubricate the threads with oil.
   d. All of the above
   e. None of the above

13. Technician A says that they must reduce the acetylene flow until the flame just starts to produce black smoke around its edges. Technician B says that the acetylene flow must then be increased until the smoke disappears. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

14. Dirty orifices on the cutting tip can produce:
   a. Wide kerfs.
   b. Adherent slag.
   c. Rough cut appearance.
   d. All of the above.
   e. None of the above

15. Technician A says that, for cutting holes, the torch must be held parallel to the base metal throughout the cut. Technician B says that square cuts require the torch to be held at 45° to the base metal. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

16. Lag lines are the result of
   a. Correct travel speed.
   b. Too great a travel speed.
   c. Too slow a travel speed.
   d. Incorrect torch angle.
   e. None of the above

17. When extinguishing the torch, Technician A says that the acetylene torch valve should be closed first. Technician B says that the oxygen torch valve should be closed first. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

18. Good oxy-fuel cuts require an oxygen purity of at least:
   a. 99.5%.
   b. 95.9%.
   c. 59.9%.
   d. None of the above.

19. Both acetylene and oxygen lines should be __________ when closing down the work station.
   a. Removed
   b. Cleaned with acetone
   c. Bled free of gas or fuel
   d. All of the above
   e. None of the above

20. Technician A says that since B is left-handed, B should cut from left to right. Technician B says that the pre-heat flame should still be from 1/6" to 1/2" from the base metal, regardless of the direction of travel. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

WLD-K6
Describe Techniques for Preventing or Reducing Welding Related Distortion
Self-Assessment No. 1 Answer Key

1. c
2. b
3. b
4. b
5. a
6. d
7. a
8. c
9. a
10. e
11. d
12. b
13. c
14. d
15. d
16. b
17. a
18. a
19. c
20. c

Name: ____________________ Date: ____________________

WLD-K6
Describe Techniques for Preventing or Reducing Welding Related Distortion
Self-Assessment No. 2

1. What is the major difference between a brazed joint and a welded joint?

2. What two conditions determines whether the joint is brazed or welded?

3. How does flux act as a guide to the temperature of the joint?

4. What is the color of the plate when it is at the proper temperature for welding?

5. Is brazing stronger than fusion welding?

6. For silver soldering: what is a 3x flame?

7. What alloys are contained in typical silver soldering?

8. How can material be prepared for silver soldering?

9. Is it possible to make fillets when using silver soldering alloys?

WELDER SERIES

MASTER Technical Module No. WLD-K07

SUBJECT: **WELDING TECHNICIAN** **TIME: 8 HOURS**

- **DUTY:** **OXYACETYLENE CUTTING AND WELDING**
- **TASK:** Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform welding with mild steel and carbon steel using variety of joints and types of leads and welds;
B. Weld intermittent blocks to decrease distortion;
C. Learn other techniques to prevent warpage and distortion; and,
D. Remove distortion using gas equipment.

INSTRUCTIONAL MATERIALS:

Student Workbook
Four written tests on oxyacetylene safety, and procedures
Transparencies will be used to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video Material
    Classroom handouts consisting of student worksheets and alloy charts
Hobart OAW wall chart
Personal protective equipment
Oxyfuel welding equipment
Oxygen and fuel gas cylinders
Oxygen and fuel gas regulators
Torch handles
Welding and cutting tips
Cutting torch assemblies
Lighters
Selection of filler metals and oxyfuel welding rod
Selection of base metals for welding and cutting
Welding shop tools
MASTER Handout (WLD-K7-HO)
MASTER Laboratory Aid (WLD-K7-LA)
MASTER Laboratory Worksheet No. 1 (WLD-K7-LW1)
MASTER Laboratory Worksheet No. 2 (WLD-K7-LW2)

MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Keller's Official OSHA Safety Handbook, T.J Keller and Associates, Inc., ISBN 1-877798-21-5, Latest Edition
Operator's Manual for Oxyfuel Gas Cutting, ANSI/AWS C4.1G, Latest Edition
Welding Handbook, Volume One, Welding Technology WHB-1.8, Latest Edition
Specification for Qualification and Certification for Entry Level Welders, AWS QC10, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses.

WLD-K1	"Identify and Describe the Function of Each Piece of Equipment"
WLD-K2	"Identify the Safety Hazards"
WLD-K3	"Describe Preventive and/or Protective Measures"
WLD-K4	"List the Welding Variables and Describe Their Effects on Weld Quality"
WLD-K5	"Describe the AWS Oxyfuel Gas Welding Rod Classification System"
WLD-K6	"Describe Techniques for Preventing or Reducing Welding Related Distortion"

INTRODUCTION:

The Course Introduction will Include:

- An overview of methods to minimize the effects of distortion
- A class demonstration of effective welding techniques to prevent warpage and distortion.

PRESENTATION OUTLINE:

Instruction Topics:

A. Identify safety hazards
B. Describe preventive and protective measures
C. Illustrate the function of oxyacetylene equipment
D. Illustrate discontinuities and their effects on weld quality
E. Illustrate AWS Oxyacetylene Rod Classification System
F. Illustrate techniques for preventing or reducing weld related distortion, weld flat plate using stringer bead in flat and horizontal, vertical, and overhead positions; flat plate using weave bead in flat position; lap joint using filler weld in flat position, horizontal, vertical, and overhead positions.
G. Illustrate variables associated with cutting
H. Remove distortion using gas equipment

Student Activities:

A. Cut mild steel plates in a safe manner
B. Remove discontinuities from cut area using grinders and files
C. Remove oxidation prior to and after welding
D. Oxyacetylene weld practice pieces using multiple positions

PRACTICAL APPLICATION:

The student will set-up oxyacetylene equipment in a safe and cautious manner, wearing personal protective equipment, and demonstrating awareness of safe techniques in the horizontal, vertical, and overhead positions. When welding various metals the student will chart the compatible filler materials and alloys used in the process.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Student practical exercises will be evaluated by the instructor.

SUMMARY:

Continued emphasis will be on oxyacetylene safety and the dangers of using gas tanks and gas lines. The class will discuss alloy compatibility using the oxyacetylene welding process.

A discussion will be conducted on preventing or reducing weld related distortion and weld quality. Practical exercises are designed to help the student minimize the effects of distortion.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-K8) dealing with listing the variables associated with cutting.

WLD-K7-HO
Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform welding with mild steel and carbon steel using variety of joints and types of leads and welds;
B. Weld intermittent blocks to decrease distortion;
C. Learn other techniques to prevent warpage and distortion; and,
D. Remove distortion using gas equipment.

MODULE OUTLINE:

Instruction Topics:

A. Identify safety hazards
B. Describe preventive and protective measures
C. Illustrate the function of oxyacetylene equipment
D. Illustrate discontinuities and their effects on weld quality
E. Illustrate AWS Oxyacetylene Rod Classification System
F. Illustrate techniques for preventing or reducing weld related distortion, weld flat plate using stringer bead in flat and horizontal, vertical, and overhead positions; flat plate using weave bead in flat position; lap joint using filler weld in flat position, horizontal, vertical, and overhead positions.
G. Illustrate variables associated with cutting
H. Remove distortion using gas equipment

Student Activities:

A. Cut mild steel plates in a safe manner
B. Remove discontinuities from cut area using grinders and files
C. Remove oxidation prior to and after welding
D. Oxyacetylene weld practice pieces using multiple positions

WLD-K7-LA
Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion
Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.

j. Never tamper with fusible plugs or other safety devices on cylinders.
k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.
l. Never use any cylinder, full or empty, as a roller or support.
m. Never use oxygen as though it were compressed air.
n. Do not handle oxygen cylinders on the same platform with oil.
o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
p. Store oxygen cylinders separately from fuel gas cylinders.
q. Always keep empty cylinders separate from full cylinders.
r. Mark all empty cylinders as such after use.
s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
t. Never bring any arc or flame close to or directly into contact with a cylinder.
u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K7-LW1

Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion

Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?

2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?

3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?

4. What are the steps in preparing to cut with oxyacetylene?

5. What are the steps in lighting the torch?

6. What are the steps in cutting metal with the torch?

7. What are the steps in extinguishing the torch?

8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
   - a. Use goggles or shield with a number five shade.
   - b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
   - c. When lighting the torch, direct the torch away from yourself and other personnel.
   - d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
   - e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
   - f. Never cut on containers that have contained flammable or toxic substances.
   - g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
   - h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
   a. Keep acetylene operating pressures at or below 15 psi.
   b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   g. Never use a cylinder that is leaking.
   h. Store and transport cylinders in the upright position.
   i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   j. Never tamper with fusible plugs or other safety devices on cylinders.
   k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   l. Never use any cylinder, full or empty, as a roller or support.
   m. Never use oxygen as though it were compressed air.
   n. Do not handle oxygen cylinders on the same platform with oil.
   o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
   p. Store oxygen cylinders separately from fuel gas cylinders.
   q. Always keep empty cylinders separate from full cylinders.
   r. Mark all empty cylinders as such after use.
   s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   t. Never bring any arc or flame close to or directly into contact with a cylinder.
   u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
   a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
   b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
   c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
   d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
   a. Obtain the proper size cutting tip.
      (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
      (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
   b. Screw the cutting torch head in place, hand-tight only.
   c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
   d. Attach the regulators, hoses, torch, and correct-sized torch tip.
   e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
   f. Make sure all cutting torch valves are initially closed.
   g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
   h. Open the acetylene torch valve. Turn the acetylene torch valve off.

i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
j. Turn the acetylene torch valve off.
k. Turn both oxygen torch valves on.
l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
    a. Put on gloves.
    b. Put on welding goggles.
    c. Open the torch acetylene valve one-half turn.
    d. Immediately light the torch with a *friction lighter only.*
    e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
    f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
        (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
        (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
    a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
        (1) Cutting tip size.
        (2) Oxygen operating pressure.
        (3) Acetylene operating pressure.
        (4) Preheat flame type.
        (5) Size of preheat flame
    b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
    c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
    d. Select the correct torch angle.
        (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
        (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

    (3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed,* the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
    a. Close the torch acetylene valve, thus extinguishing the flame.
    b. Close the torch oxygen valve.

8 Steps in closing down the welding station:
    a. Close the oxygen cylinder valve.
    b. Close the acetylene cylinder valve.
    c. Open the torch acetylene valve and bleed the acetylene from the line.
    d. Close the torch acetylene valve.
    e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
    f. Open the torch oxygen valve and bleed the oxygen from the line.
    g. Close the torch oxygen valve.
    h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K7-LW2
Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion
Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

Name: ______________________________ Date: ___________________________

WLD-K7

Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion

Self-Assessment No. 1

Circle the best answer.

1. Which of the following can be used to ignite an oxyacetylene torch?
   a. Matches
   b. A cigarette lighter
   c. A spark or friction lighter
   d. Any of the above
   e. None of the above

2. Technician A says that they can cut into an old gasoline can with the torch. Technician B says that containers of flammable or toxic substances should never be cut with a torch. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

3. If adequate ventilation is unavailable, the technician should:
   a. Cut the metal anyway; ventilation is not important.
   b. Cut the metal while wearing a respirator.
   c. Cut the metal while wearing a heavy-duty dust mask.
   d. Refuse to make the cut.

4. Acetylene operating pressures must be kept at or below:
   a. 5 psi.
   b. 15 psi.
   c. 25 psi.
   d. Acetylene operating pressures are immaterial.

5. Acetylene hoses are __________; acetylene fittings are __________.
   a. Red - left-handed
   b. Blue - left-handed
   c. Red - right-handed
   d. Blue - left-handed
   e. None of the above

6. All cylinders should be secured except when:
   a. Transporting them.
   b. Storing them.
   c. Using them.
   d. Always secure cylinders with chains or in permanent racks.
   e. Securing cylinders is unnecessary.

7. Technician A says that oxygen cylinders should be stored well away from fuel gas cylinders. Technician B says that separate storage is unnecessary. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

8. The maximum safe withdrawal rate for acetylene cylinders is:
   a. One fourth of current content per hour.
   b. One fifth of current content per hour.
   c. One seventh of current content per hour.
   d. One tenth of current content per hour.
   e. None of the above

9. Technician A says that only oxygen-specific regulators can be used on oxygen cylinders. Technician B says that it is acceptable to use oxygen regulators on other gas cylinders. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

10. Which of the following can be cut with an oxyacetylene torch?
    a. Aluminum
    b. Copper
    c. Chromium
    d. All of the above
    e. None of the above

11. Technician A says that the acetylene cylinder's valve should be opened all the way. Technician B says that the oxygen cylinder's valve should be opened no more than one full turn. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

12. Before attaching the regulators to the cylinder valves:
    a. Clean the nipples with acetone.
    b. Crack the valves to blow out any dirt.
    c. Lubricate the threads with oil.
    d. All of the above
    e. None of the above

13. Technician A says that they must reduce the acetylene flow until the flame just starts to produce black smoke around its edges. Technician B says that the acetylene flow must then be increased until the smoke disappears. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

14. Dirty orifices on the cutting tip can produce:
    a. Wide kerfs.
    b. Adherent slag.
    c. Rough cut appearance.
    d. All of the above.
    e. None of the above

15. Technician A says that, for cutting holes, the torch must be held parallel to the base metal throughout the cut. Technician B says that square cuts require the torch to be held at 45° to the base metal. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

16. Lag lines are the result of
    a. Correct travel speed.
    b. Too great a travel speed.
    c. Too slow a travel speed.
    d. Incorrect torch angle.
    e. None of the above

17. When extinguishing the torch, Technician A says that the acetylene torch valve should be closed first. Technician B says that the oxygen torch valve should be closed first. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

18. Good oxy-fuel cuts require an oxygen purity of at least:
a. 99.5%.
b. 95.9%.
c. 59.9%.
d. None of the above.

19. Both acetylene and oxygen lines should be __________ when closing down the work station.
a. Removed
b. Cleaned with acetone
c. Bled free of gas or fuel
d. All of the above
e. None of the above

20. Technician A says that since B is left-handed, B should cut from left to right. Technician B says that the pre-heat flame should still be from 1/6" to 1/2" from the base metal, regardless of the direction of travel. Who is correct?
a. Technician A only
b. Technician B only
c. Both Technicians A and B
d. Neither Technician A nor B

WLD-K7
Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion
Self-Assessment No. 1 Answer Key

1. c
2. b
3. b
4. b
5. a
6. d
7. a
8. c
9. a
10. e
11. d
12. b
13. c
14. d
15. d
16. b
17. a
18. a
19. c
20. c

Name: ______________________ Date: ____________________

WLD-K7
Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion
Self-Assessment No. 2

1. What is the major difference between a brazed joint and a welded joint?

____

____

____

2. What two conditions determines whether the joint is brazed or welded?

____

____

____

3. How does flux act as a guide to the temperature of the joint?

____

____

____

4. What is the color of the plate when it is at the proper temperature for welding?

____

____

____

5. Is brazing stronger than fusion welding?

____

____

____

6. For silver soldering: what is a 3x flame?

____

____

____

7. What alloys are contained in typical silver soldering?

____

____

____

8. How can material be prepared for silver soldering?

9. Is it possible to make fillets when using silver soldering alloys?

WELDER SERIES

MASTER Technical Module No. WLD-K08

SUBJECT: **WELDING TECHNICIAN** **TIME: 15 HOURS**

- **DUTY:** **OXYACETYLENE CUTTING AND WELDING**
- **TASK:** List the Variables Associated With Cutting

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to shape cutting operations using manual oxyfuel gas cutting equipment;
B. Provide instruction related to visual examination of flame cut edges and surfaces;
C. Demonstrate straight cuts on mild steel of 1/8", 1/4", 1/2", bevel cuts of 3/8", cut holes and shapes on 1/4" and 1/2";
D. Provide training exercises related to shape cutting operations on plain carbon steel, using manual oxyfuel gas cutting equipment;
E. Observe safe oxyfuel gas cutting practices;
F. Operate manual oxyfuel gas cutting and "track burner" equipment;
G. Visually inspect workmanship samples;
H. Understand various methods of cutting; and,
I.. Understand different tip sizes for material thickness.

INSTRUCTIONAL MATERIALS:

Student Workbook
Two written tests on cutting techniques and procedures
Transparencies will be used to emphasize each subject
Hobart Institute Video Material
Classroom handouts consisting of student worksheets and alloy charts
Hobart OAW wall chart
Personal protective equipment
Oxyfuel welding equipment
Oxygen and fuel gas cylinders
Oxygen and fuel gas regulators
Torch handles
Welding and cutting tips
Cutting torch assemblies
Lighters
Selection of filler metals and oxyfuel welding rod

Selection of base metals for welding and cutting
Welding shop tools
MASTER Handout (WLD-K8-HO)
MASTER Laboratory Aid (WLD-K8-LA)
MASTER Laboratory Worksheet No. 1 (WLD-K8-LW1)
MASTER Laboratory Worksheet No. 2 (WLD-K8-LW2)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Keller's Official OSHA Safety Handbook, T.J Keller and Associates, Inc., ISBN 1-877798-21-5, Latest Edition
Operator's Manual for Oxyfuel Gas Cutting, ANSI/AWS C4.1G, Latest Edition
Welding Handbook, Volume One, Welding Technology WHB-1.8, Latest Edition
Specification for Qualification and Certification for Entry Level Welders, AWS QC10, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses.

WLD-K1	"Identify and Describe the Function of Each Piece of Equipment"
WLD-K2	"Identify the Safety Hazards"
WLD-K3	"Describe Preventive and/or Protective Measures"

WLD-K4	"List the Welding Variables and Describe Their Effects on Weld Quality"
WLD-K5	"Describe the AWS Oxyfuel Gas Welding Rod Classification System"
WLD-K6	"Describe Techniques for Preventing or Reducing Welding Related Distortion"
WLD-K7	"Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion"

INTRODUCTION:

The Course Introduction will Include:

- The many applications for metal cutting processes
- Advantages and disadvantages of the processes and methods in use

---

PRESENTATION OUTLINE:

Instruction Topics:

A. Identify safety hazards in oxyfuel gas cutting operations
B. Describe preventive and protective measures
C. Selection of tips for cutting
D. Demonstrate kerfing, gauging, scarfing, and washing
E. Demonstration on cutting steel: straight cuts, bevel cuts, holes and shapes
F. Demonstrate cutting methods in flat or horizontal, vertical, and overhead positions
G. Operation of manual oxyfuel gas cutting and track burner equipment
H. Importance of quality and safety in cutting methods
I. Review other methods of cutting (plasma, laser, water jet), with advantages and disadvantages
J. Evaluating quality of final workmanship

Student Activities:

A. Demonstrate safe techniques in use of oxyfuel gas cutting equipment
B. Perform straight cutting operations using manual oxyfuel gas cutting equipment
C. Perform straight cutting operations on plain carbon steel
D. Demonstrate straight cuts on mild steel of 1/8", 1/4", 1/2", bevel cuts of 3/8", cut holes and shapes on 1/4" and 1/2" with major emphasis on safety practice cutting from multiple positions under close supervision of instructor
E. Use "track burner" equipment
F. Perform shape cutting operations on plain carbon steel, using manual oxyfuel gas cutting equipment
G. Select and change tip size for material, appropriate size to each operation
H. Review different methods of cutting (i.e. plasma, laser, water jet, etc.)

PRACTICAL APPLICATION:

The student will set-up oxyacetylene equipment in a safe and cautious manner, wearing personal protective equipment, and being aware of safety variables in horizontal, vertical, and overhead positions. Tip selection and size, or selection of applicable cutting torch will be elements of the welding decisions for cutting methods.

EVALUATION AND/OR VERIFICATION:

Two written examinations and fifteen practical exercises will be featured in this module. Practical exercises will be critiqued by students and instructor.

SUMMARY:

Students must be knowledgeable of the variables associated with cutting of metals with varying thickness in the horizontal, vertical, and overhead positions. Oxygen cutting, also referred to as *flame cutting* or *torch cutting*, is frequently used for many purposes, including cutting metals to a desired size or shape; cutting bevels for weld joint edge preparation; gouging or cutting grooves in metal surfaces; piercing holes or cutting sections out of metal sheets; and removing rough areas or surface defects from metal ingots and bars. Oxygen cutting can also be used to cut away rivets or bolts or to break welds in dismantling metal assembly or structure.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-K9) dealing with cutting mild steel plate in a safe manner.

WLD-K8-HO
List the Variables Associated with Cutting
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to shape cutting operations using manual oxyfuel gas cutting equipment;
B. Provide instruction related to visual examination of flame cut edges and surfaces;
C. Demonstrate straight cuts on mild steel of 1/8", 1/4", 1/2", bevel cuts of 3/8", cut holes and shapes on 1/4" and 1/2";
D. Provide training exercises related to shape cutting operations on plain carbon steel, using manual oxyfuel gas cutting equipment;
E. Observe safe oxyfuel gas cutting practices;
F. Operate manual oxyfuel gas cutting and "track burner" equipment;
G. Visually inspect workmanship samples;
H. Understand various methods of cutting; and,
I.. Understand different tip sizes for material thickness.

MODULE OUTLINE:

Instruction Topics:

A. Identify safety hazards in oxyfuel gas cutting operations
B. Describe preventive and protective measures
C. Selection of tips for cutting
D. Demonstrate kerfing, gauging, scarfing, and washing
E. Demonstration on cutting steel: straight cuts, bevel cuts, holes and shapes
F. Demonstrate cutting methods in flat or horizontal, vertical, and overhead positions
G. Operation of manual oxyfuel gas cutting and track burner equipment
H. Importance of quality and safety in cutting methods
I. Review other methods of cutting (plasma, laser, water jet), with advantages and disadvantages
J. Evaluating quality of final workmanship

Student Activities:

A. Demonstrate safe techniques in use of oxyfuel gas cutting equipment
B. Perform straight cutting operations using manual oxyfuel gas cutting equipment
C. Perform straight cutting operations on plain carbon steel
D. Demonstrate straight cuts on mild steel of 1/8", 1/4", 1/2", bevel cuts of 3/8", cut holes and shapes on 1/4" and 1/2" with major emphasis on safety practice cutting from multiple positions under close supervision of instructor

E. Use "track burner" equipment

F. Perform shape cutting operations on plain carbon steel, using manual oxyfuel gas cutting equipment

G. Select and change tip size for material, appropriate size to each operation

H. Review different methods of cutting (i.e. plasma, laser, water jet, etc.)

WLD-K8-LA
List the Variables Associated with Cutting
Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.
l. Never use any cylinder, full or empty, as a roller or support.
m. Never use oxygen as though it were compressed air.
n. Do not handle oxygen cylinders on the same platform with oil.
o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
p. Store oxygen cylinders separately from fuel gas cylinders.
q. Always keep empty cylinders separate from full cylinders.
r. Mark all empty cylinders as such after use.
s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
t. Never bring any arc or flame close to or directly into contact with a cylinder.
u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K8-LW1
List the Variables Associated with Cutting
Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?
2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?
3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?
4. What are the steps in preparing to cut with oxyacetylene?
5. What are the steps in lighting the torch?
6. What are the steps in cutting metal with the torch?
7. What are the steps in extinguishing the torch?
8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
    a. Use goggles or shield with a number five shade.
    b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
    c. When lighting the torch, direct the torch away from yourself and other personnel.
    d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
    e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
    f. Never cut on containers that have contained flammable or toxic substances.
    g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
    h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
   a. Keep acetylene operating pressures at or below 15 psi.
   b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   g. Never use a cylinder that is leaking.
   h. Store and transport cylinders in the upright position.
   i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   j. Never tamper with fusible plugs or other safety devices on cylinders.
   k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   l. Never use any cylinder, full or empty, as a roller or support.
   m. Never use oxygen as though it were compressed air.
   n. Do not handle oxygen cylinders on the same platform with oil.
   o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
   p. Store oxygen cylinders separately from fuel gas cylinders.
   q. Always keep empty cylinders separate from full cylinders.
   r. Mark all empty cylinders as such after use.
   s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   t. Never bring any arc or flame close to or directly into contact with a cylinder.
   u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
    a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
    b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
    c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
    d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
    a. Obtain the proper size cutting tip.
        (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
        (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
    b. Screw the cutting torch head in place, hand-tight only.
    c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
    d. Attach the regulators, hoses, torch, and correct-sized torch tip.
    e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
    f. Make sure all cutting torch valves are initially closed.
    g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
    h. Open the acetylene torch valve. Turn the acetylene torch valve off.

- i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
- j. Turn the acetylene torch valve off.
- k. Turn both oxygen torch valves on.
- l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
- m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   - a. Put on gloves.
   - b. Put on welding goggles.
   - c. Open the torch acetylene valve one-half turn.
   - d. Immediately light the torch with a *friction lighter only.*
   - e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   - f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
     - (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
     - (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   - a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
     - (1) Cutting tip size.
     - (2) Oxygen operating pressure.
     - (3) Acetylene operating pressure.
     - (4) Preheat flame type.
     - (5) Size of preheat flame
   - b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
   - c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
   - d. Select the correct torch angle.
     - (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
     - (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

(3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed,* the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. Open the torch acetylene valve and bleed the acetylene from the line.
   d. Close the torch acetylene valve.
   e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
   f. Open the torch oxygen valve and bleed the oxygen from the line.
   g. Close the torch oxygen valve.
   h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K8-LW2
List the Variables Associated with Cutting
Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod.
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

Name: ______________________________ Date: ___________________________

WLD-K8
List the Variables Associated with Cutting
Self-Assessment No. 1

Circle the best answer.

1. Which of the following can be used to ignite an oxyacetylene torch?
   a. Matches
   b. A cigarette lighter
   c. A spark or friction lighter
   d. Any of the above
   e. None of the above

2. Technician A says that they can cut into an old gasoline can with the torch. Technician B says that containers of flammable or toxic substances should never be cut with a torch. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

3. If adequate ventilation is unavailable, the technician should:
   a. Cut the metal anyway; ventilation is not important.
   b. Cut the metal while wearing a respirator.
   c. Cut the metal while wearing a heavy-duty dust mask.
   d. Refuse to make the cut.

4. Acetylene operating pressures must be kept at or below:
   a. 5 psi.
   b. 15 psi.
   c. 25 psi.
   d. Acetylene operating pressures are immaterial.

5. Acetylene hoses are __________; acetylene fittings are __________.
   a. Red - left-handed
   b. Blue - left-handed
   c. Red - right-handed
   d. Blue - left-handed
   e. None of the above

6. All cylinders should be secured except when:
   a. Transporting them.
   b. Storing them.
   c. Using them.
   d. Always secure cylinders with chains or in permanent racks.
   e. Securing cylinders is unnecessary.

7. Technician A says that oxygen cylinders should be stored well away from fuel gas cylinders. Technician B says that separate storage is unnecessary. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

8. The maximum safe withdrawal rate for acetylene cylinders is:
   a. One fourth of current content per hour.
   b. One fifth of current content per hour.
   c. One seventh of current content per hour.
   d. One tenth of current content per hour.
   e. None of the above

9. Technician A says that only oxygen-specific regulators can be used on oxygen cylinders. Technician B says that it is acceptable to use oxygen regulators on other gas cylinders. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

10. Which of the following can be cut with an oxyacetylene torch?
    a. Aluminum
    b. Copper
    c. Chromium
    d. All of the above
    e. None of the above

11. Technician A says that the acetylene cylinder's valve should be opened all the way. Technician B says that the oxygen cylinder's valve should be opened no more than one full turn. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

12. Before attaching the regulators to the cylinder valves:
  a. Clean the nipples with acetone.
  b. Crack the valves to blow out any dirt.
  c. Lubricate the threads with oil.
  d. All of the above
  e. None of the above

13. Technician A says that they must reduce the acetylene flow until the flame just starts to produce black smoke around its edges. Technician B says that the acetylene flow must then be increased until the smoke disappears. Who is correct?
  a. Technician A only
  b. Technician B only
  c. Both Technicians A and B
  d. Neither Technician A nor B

14. Dirty orifices on the cutting tip can produce:
  a. Wide kerfs.
  b. Adherent slag.
  c. Rough cut appearance.
  d. All of the above.
  e. None of the above

15. Technician A says that, for cutting holes, the torch must be held parallel to the base metal throughout the cut. Technician B says that square cuts require the torch to be held at 45° to the base metal. Who is correct?
  a. Technician A only
  b. Technician B only
  c. Both Technicians A and B
  d. Neither Technician A nor B

16. Lag lines are the result of
  a. Correct travel speed.
  b. Too great a travel speed.
  c. Too slow a travel speed.
  d. Incorrect torch angle.
  e. None of the above

17. When extinguishing the torch, Technician A says that the acetylene torch valve should be closed first. Technician B says that the oxygen torch valve should be closed first. Who is correct?
  a. Technician A only
  b. Technician B only
  c. Both Technicians A and B
  d. Neither Technician A nor B

18. Good oxy-fuel cuts require an oxygen purity of at least:
   a. 99.5%.
   b. 95.9%.
   c. 59.9%.
   d. None of the above.

19. Both acetylene and oxygen lines should be __________ when closing down the work station.
   a. Removed
   b. Cleaned with acetone
   c. Bled free of gas or fuel
   d. All of the above
   e. None of the above

20. Technician A says that since B is left-handed, B should cut from left to right. Technician B says that the pre-heat flame should still be from 1/6" to 1/2" from the base metal, regardless of the direction of travel. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

WLD-K8
List the Variables Associated with Cutting
Self-Assessment No. 1 Answer Key

1.	c
2.	b
3.	b
4.	b
5.	a
6.	d
7.	a
8.	c
9.	a
10.	e
11.	d
12.	b
13.	c
14.	d
15.	d
16.	b
17.	a
18.	a
19.	c
20.	c

Name: ______________________________ Date: _________________________

WLD-K8
List the Variables Associated with Cutting
Self-Assessment No. 2

1. What is the major difference between a brazed joint and a welded joint?

2. What two conditions determines whether the joint is brazed or welded?

3. How does flux act as a guide to the temperature of the joint?

4. What is the color of the plate when it is at the proper temperature for welding?

5. Is brazing stronger than fusion welding?

6. For silver soldering: what is a 3x flame?

7. What alloys are contained in typical silver soldering?

8. How can material be prepared for silver soldering?

9. Is it possible to make fillets when using silver soldering alloys?

WELDER SERIES

MASTER Technical Module No. WLD-K09

SUBJECT: WELDING TECHNICIAN TIME: 12 HOURS

- **DUTY: OXYACETYLENE CUTTING AND WELDING**
- **TASK:** Cut Mild Steel Plate in a Safe Manner

OBJECTIVE(S):

Upon completion of this unit, the student will be able to:

A. Perform quality multipass single vee groove welds;
B. Perform quality vee groove weld that will pass a guided bend test;
C. Produce quality single vee groove welds in the vertical position;
D. Produce quality single vee groove welds in the overhead position;
E. Produce quality single vee groove welds in the horizontal position;
F. Visually inspect workmanship samples; and,
G. Understand all welding procedures.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on welding techniques and destructive testing
Transparencies will be used to emphasize each subject
Hobart Institute Video Material
Classroom handouts consisting of student worksheets with characteristics of carbon steel and alloy charts
Hobart OAW wall chart
Personal protective equipment
Oxyfuel welding equipment
Oxygen and fuel gas cylinders
Oxygen and fuel gas regulators
Torch handles
Welding and cutting tips
Cutting torch assemblies
Lighters
Selection of filler metals and oxyfuel welding rod
Selection of base metals for welding and cutting
Welding shop tools
MASTER Handout (WLD-K9-HO)
MASTER Laboratory Aid (WLD-K9-LA)
MASTER Laboratory Worksheet No. 1 (WLD-K9-LW1)

MASTER Laboratory Worksheet No. 2 (WLD-K9-LW2)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN. 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig, New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Keller's Official OSHA Safety Handbook, T.J Keller and Associates, Inc., ISBN 1-877798-21-5, Latest Edition
Operator's Manual for Oxyfuel Gas Cutting, ANSI/AWS C4.1G, Latest Edition
Welding Handbook, Volume One, Welding Technology WHB-1.8, Latest Edition
Specification for Qualification and Certification for Entry Level Welders, AWS QC10, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses.

WLD-K1	"Identify and Describe the Function of Each Piece of Equipment"
WLD-K2	"Identify the Safety Hazards"
WLD-K3	"Describe Preventive and/or Protective Measures"
WLD-K4	"List the Welding Variables and Describe Their Effects on Weld Quality"
WLD-K5	"Describe the AWS Oxyfuel Gas Welding Rod Classification System"
WLD-K6	"Describe Techniques for Preventing or Reducing Welding Related

	Distortion"
WLD-K7	"Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion"
WLD-K8	"List the Variables Associated With Cutting"

INTRODUCTION:

The Course Introduction will Include:

- An overview of a fast growing technical field with many opportunities and excellent pay
- A class demonstration of gas welding techniques with carbon steels
- A discussion on training activities resulting in an increase of skill and knowledge leading to certification in related program areas, becoming a more valuable employee.

PRESENTATION OUTLINE:

Instruction Topics:

A. Identify safety hazards.
B. Describe preventive and protective measures.
C. Demonstrate forcehand or backhand motions for gas welding
D. Adjust gas working pressures according to tip size, producing good fusion
E. Present and demonstrate welding techniques in the flat or horizontal, vertical, and overhead positions
F. Discuss types of welds and joints for carbon steel.
G. Discuss how to perform Single Groove Weld Guided Bend Test.

Student Activities:

Perform the following welding exercises:

A. Single Vee Groove Weld, Butt Joint, Flat Position
B. Single Vee Groove Weld, Guided Bend Test
C. Single Vee Groove Weld, Butt Joint, Vertical Position,
D. Single Vee Groove Weld, Butt Joint, Overhead Position
E. Single Vee Groove Weld, Butt Joint, Horizontal Position
F. Discuss advantages and disadvantages of typical gas working pressures

PRACTICAL APPLICATION:

The student will set-up oxyacetylene equipment in a safe and cautious manner, wearing personal protective equipment, and being aware of hazards of working in vertical and overhead position. When welding various metals the student will chart the compatible alloys used in the process. The student will also demonstrate welding techniques and adjust working pressures in a capable manner.

EVALUATION AND/OR VERIFICATION:

Two written examinations will be given during this to determine student progress. Five or more welding exercises will be conducted by the student and evaluated by the instructor.

SUMMARY:

Emphasis will be on practical work, using quality techniques to gas weld carbon steel. The class will discuss alloy compatibility using filler materials. Discussion will continue on preventing or reducing weld related distortion and improving weld quality. Students will apply quality weld techniques, and capably adjust working pressures.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-L1) dealing with preheating joint.

WLD-K9-HO
Cut Mild Steel Plate in a Safe Manner
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit, the student will be able to:

A. Perform quality multipass single vee groove welds;
B. Perform quality vee groove weld that will pass a guided bend test;
C. Produce quality single vee groove welds in the vertical position;
D. Produce quality single vee groove welds in the overhead position;
E. Produce quality single vee groove welds in the horizontal position;
F. Visually inspect workmanship samples; and,
G. Understand all welding procedures.

MODULE OUTLINE:

Instruction Topics:

A. Identify safety hazards.
B. Describe preventive and protective measures.
C. Demonstrate forcehand or backhand motions for gas welding
D. Adjust gas working pressures according to tip size, producing good fusion
E. Present and demonstrate welding techniques in the flat or horizontal, vertical, and overhead positions
F. Discuss types of welds and joints for carbon steel.
G. Discuss how to perform Single Groove Weld Guided Bend Test.

Student Activities:

Perform the following welding exercises:

A. Single Vee Groove Weld, Butt Joint, Flat Position
B. Single Vee Groove Weld, Guided Bend Test
C. Single Vee Groove Weld, Butt Joint, Vertical Position,
D. Single Vee Groove Weld, Butt Joint, Overhead Position
E. Single Vee Groove Weld, Butt Joint, Horizontal Position
F. Discuss advantages and disadvantages of typical gas working pressures

WLD-K9-LA
Cut Mild Steel Plate in a Safe Manner
Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K9-LW1
Cut Mild Steel Plate in a Safe Manner
Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?
2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?
3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?
4. What are the steps in preparing to cut with oxyacetylene?
5. What are the steps in lighting the torch?
6. What are the steps in cutting metal with the torch?
7. What are the steps in extinguishing the torch?
8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
   a. Use goggles or shield with a number five shade.
   b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
   c. When lighting the torch, direct the torch away from yourself and other personnel.
   d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
   e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
   f. Never cut on containers that have contained flammable or toxic substances.
   g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
   h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

    i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
    j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
    k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
    a. Keep acetylene operating pressures at or below 15 psi.
    b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
    c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
    d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
    e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
    f. Do not use pipe-fitting compounds or thread lubricants for making connections.
    g. Never use a cylinder that is leaking.
    h. Store and transport cylinders in the upright position.
    i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
    j. Never tamper with fusible plugs or other safety devices on cylinders.
    k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
    l. Never use any cylinder, full or empty, as a roller or support.
    m. Never use oxygen as though it were compressed air.
    n. Do not handle oxygen cylinders on the same platform with oil.
    o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
    p. Store oxygen cylinders separately from fuel gas cylinders.
    q. Always keep empty cylinders separate from full cylinders.
    r. Mark all empty cylinders as such after use.
    s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
    t. Never bring any arc or flame close to or directly into contact with a cylinder.
    u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
    a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
    b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
    c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
    d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
    a. Obtain the proper size cutting tip.
        (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
        (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
    b. Screw the cutting torch head in place, hand-tight only.
    c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
    d. Attach the regulators, hoses, torch, and correct-sized torch tip.
    e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
    f. Make sure all cutting torch valves are initially closed.
    g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
    h. Open the acetylene torch valve. Turn the acetylene torch valve off.

i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
j. Turn the acetylene torch valve off.
k. Turn both oxygen torch valves on.
l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   a. Put on gloves.
   b. Put on welding goggles.
   c. Open the torch acetylene valve one-half turn.
   d. Immediately light the torch with a *friction lighter only*.
   e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
      (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
      (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
      (1) Cutting tip size.
      (2) Oxygen operating pressure.
      (3) Acetylene operating pressure.
      (4) Preheat flame type.
      (5) Size of preheat flame
   b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
   c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
   d. Select the correct torch angle.
      (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
      (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

(3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed,* the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. Open the torch acetylene valve and bleed the acetylene from the line.
   d. Close the torch acetylene valve.
   e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
   f. Open the torch oxygen valve and bleed the oxygen from the line.
   g. Close the torch oxygen valve.
   h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K9-LW2
Cut Mild Steel Plate in a Safe Manner
Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
Braze with bronze rod;
Run a bead with a bronze rod;
Square butt braze on light steel plate;
Braze lap joints;
Braze tee joints;
Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
Silver soldering of nonferrous metals; and,
Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
Brazing with bronze rod;
Running beads with bronze rod;
Square butt brazing on light steel plate;
Brazed lap joints;
Brazing tee joints;
Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
Silver soldering nonferrous metals; and,
Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
Running beads with bronze rod;
Square butt brazing on light steel plate;
Brazed lap joints;
Brazing tee joints;
Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
Brazing beveled joints on cast iron;
Silver soldering nonferrous metals; and,
Silver soldering ferrous and nonferrous metals.

Name: ____________________________ Date: __________________________

WLD-K9
Cut Mild Steel Plate in a Safe Manner
Self-Assessment No. 1

Circle the best answer.

1. Which of the following can be used to ignite an oxyacetylene torch?
   a. Matches
   b. A cigarette lighter
   c. A spark or friction lighter
   d. Any of the above
   e. None of the above

2. Technician A says that they can cut into an old gasoline can with the torch. Technician B says that containers of flammable or toxic substances should never be cut with a torch. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

3. If adequate ventilation is unavailable, the technician should:
   a. Cut the metal anyway; ventilation is not important.
   b. Cut the metal while wearing a respirator.
   c. Cut the metal while wearing a heavy-duty dust mask.
   d. Refuse to make the cut.

4. Acetylene operating pressures must be kept at or below:
   a. 5 psi.
   b. 15 psi.
   c. 25 psi.
   d. Acetylene operating pressures are immaterial.

5. Acetylene hoses are __________; acetylene fittings are __________.
   a. Red - left-handed
   b. Blue - left-handed
   c. Red - right-handed
   d. Blue - left-handed
   e. None of the above

6. All cylinders should be secured except when:
   a. Transporting them.
   b. Storing them.
   c. Using them.
   d. Always secure cylinders with chains or in permanent racks.
   e. Securing cylinders is unnecessary.

7. Technician A says that oxygen cylinders should be stored well away from fuel gas cylinders. Technician B says that separate storage is unnecessary. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

8. The maximum safe withdrawal rate for acetylene cylinders is:
   a. One fourth of current content per hour.
   b. One fifth of current content per hour.
   c. One seventh of current content per hour.
   d. One tenth of current content per hour.
   e. None of the above

9. Technician A says that only oxygen-specific regulators can be used on oxygen cylinders. Technician B says that it is acceptable to use oxygen regulators on other gas cylinders. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

10. Which of the following can be cut with an oxyacetylene torch?
    a. Aluminum
    b. Copper
    c. Chromium
    d. All of the above
    e. None of the above

11. Technician A says that the acetylene cylinder's valve should be opened all the way. Technician B says that the oxygen cylinder's valve should be opened no more than one full turn. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B

12. Before attaching the regulators to the cylinder valves:
   a. Clean the nipples with acetone.
   b. Crack the valves to blow out any dirt.
   c. Lubricate the threads with oil.
   d. All of the above
   e. None of the above

13. Technician A says that they must reduce the acetylene flow until the flame just starts to produce black smoke around its edges. Technician B says that the acetylene flow must then be increased until the smoke disappears. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

14. Dirty orifices on the cutting tip can produce:
   a. Wide kerfs.
   b. Adherent slag.
   c. Rough cut appearance.
   d. All of the above.
   e. None of the above

15. Technician A says that, for cutting holes, the torch must be held parallel to the base metal throughout the cut. Technician B says that square cuts require the torch to be held at 45° to the base metal. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

16. Lag lines are the result of
   a. Correct travel speed.
   b. Too great a travel speed.
   c. Too slow a travel speed.
   d. Incorrect torch angle.
   e. None of the above

17. When extinguishing the torch, Technician A says that the acetylene torch valve should be closed first. Technician B says that the oxygen torch valve should be closed first. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

18. Good oxy-fuel cuts require an oxygen purity of at least:

- a. 99.5%.
- b. 95.9%.
- c. 59.9%.
- d. None of the above.

19. Both acetylene and oxygen lines should be __________ when closing down the work station.

- a. Removed
- b. Cleaned with acetone
- c. Bled free of gas or fuel
- d. All of the above
- e. None of the above

20. Technician A says that since B is left-handed, B should cut from left to right. Technician B says that the pre-heat flame should still be from 1/6" to 1/2" from the base metal, regardless of the direction of travel. Who is correct?

- a. Technician A only
- b. Technician B only
- c. Both Technicians A and B
- d. Neither Technician A nor B

WLD-K9
Cut Mild Steel Plate in a Safe Manner
Self-Assessment No. 1 Answer Key

1. c
2. b
3. b
4. b
5. a
6. d
7. a
8. c
9. a
10. e
11. d
12. b
13. c
14. d
15. d
16. b
17. a
18. a
19. c
20. c

Name: ______________________________ Date: ________________________

WLD-K9
Cut Mild Steel Plate in a Safe Manner
Self-Assessment No. 2

1. What is the major difference between a brazed joint and a welded joint?

____

____

____

2. What two conditions determines whether the joint is brazed or welded?

____

____

____

3. How does flux act as a guide to the temperature of the joint?

____

____

____

4. What is the color of the plate when it is at the proper temperature for welding?

____

____

____

5. Is brazing stronger than fusion welding?

____

____

____

6. For silver soldering: what is a 3x flame?

____

____

____

7. What alloys are contained in typical silver soldering?

____

____

____

8. How can material be prepared for silver soldering?

____

____

____

9. Is it possible to make fillets when using silver soldering alloys?

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	[illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

Duty L1

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		← Tasks →												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required; understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on lilfe of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES

MASTER Technical Module No. WLD-L01

SUBJECT: WELDING TECHNICIAN TIME: 8 HOURS

- **DUTY:** **SHIELDED METAL ARC WELDING (SMAW) (BASIC)**
- **TASK:** Preheat Joint

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Outline safety rules for ARC Welding;
B. Properly adjust machine settings;
C. Understand basis of striking the arc electrode manipulation, and evaluating the puddle;
D. Apply the use of gas to preheat joint on mild steel plate;
E. Apply the pre-heating technique using Electrodes; and,
F. Discuss the use of other ways of preheating (Blankets, etc.).

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on Shielded Metal Arc Welding procedures
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video materials
Hobart SMAW wall chart
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Shielded Metal Arc Welding machine
Welding shop tools
Selection of base metals for welding and cutting
Selection of filler metals and electrode wire
MASTER Handout No. 1 (WLD-L1-HO1)
MASTER Handout No. 2 (WLD-L1-HO2)
MASTER Handout No. 3 (WLD-L1-HO3)
MASTER Handout No. 4 (WLD-L1-HO4)
MASTER Handout No. 5 (WLD-L1-HO5)
MASTER Handout No. 6 (WLD-L1-HO6)
MASTER Laboratory Aid (WLD-L1-LA)
MASTER Laboratory Worksheet (WLD-L1-LW)
MASTER Self-Assessment No. 1

MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Reading Welding Blueprints & Symbols, Stinchcomb, Craig, New Jersey: Prentice-Hall, Inc., Latest Edition
Certification Manual For Welding Inspector, American Welding Society, Miami, FL, (ISBN 0-87171-421-3) Latest Edition
Welding Qualifications, Practical Guide to ASME Section IX, Houle, Michael J., *CASTI* Publishing, Inc., Canada, (ISBN 0-9696428-5-7), Latest Edition
The Procedure Handbook of Arc Welding; The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of Shielded Metal Arc Welding processes
- A description of how welds are made as the arc melts consumable metal or electrodes

- A discussion on the need for preheating joints prior to welding

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Discuss the principles and theories involved in SMAW operations
B. Emphasize safety rules for ARC Welding equipment
C. Demonstrate machine settings and basis of striking the Arc
D. Electrode manipulation and reading the puddle
E. Demonstrate knowledge of joint design and welding terms
F. Demonstrate ability to interpret drawings and blueprints, using weld symbols
G. Introduce welding variables and demonstrate their effects on weld quality
H. Demonstrate knowledge of adequate preparation of welding surfaces
I. Prepare butt joints, and tee joints, for welding
J. Increase knowledge of current industry standards and techniques
K. Identify polarity requirements using SMAW on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match SMAW electrodes to an appropriate base metal

Student Activities:

A. Demonstrate knowledge of safety rules
B. Demonstrate equipment operation and setting adjustments
C. Preheat weld surface
D. Prepare and task weld coupons
E. Understand D.C. straight and reverse polarity

PRACTICAL APPLICATION:

Emphasis is placed upon ARC welding fundamentals, safety in operations, and rationale for preheating.

EVALUATION AND/OR VERIFICATION:

Two written examinations will be given during this module to determine student progress. Practical exercises will be supervised and evaluated by instructor.

SUMMARY:

Student will understand and apply Arc welding capabilities, while guarding against the hazards of using electric welding equipment. The instructor will emphasize surface preparation, preheating of material, and machine adjustments. The shielded metal arc welding (SMAW) process is probably better known to welders as the "stick electrode" process. This is because there has been very little effort to communicate correct terminology to welding people working at the trade. The process name breaks down like this:

Shielded	This word comes from the dry flux covering on the metal electrode. The flux covering which decomposes under the heat of the arc creates both a shielding gas (basically CO_2) and a slag covering for the deposited weld metal. The weld is "shielded" by these effects.
Metal Arc	The electrode is consumed under the heat of the arc and flows into the weld joint as filler metal.
Welding	The fusion that takes place between the molten filler metal from the electrode and the molten base metal is called "fusion welding."

The basic equipment required for shielded metal arc welding includes an electric arc welding power source with either AC or DC output, electrode and work welding cables, a suitable ground clamp device on the work lead, and an electrode holder with suitable amperage rating. The personal working equipment of the welder will include a welding helmet with properly shaded lens, leather gloves, a wire brush, a chipping hammer, hardened safety glasses and such other protective clothing as the job requires.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-L2) dealing with initiating welding process.

WLD-L1-HO1
Preheat Joint
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Outline safety rules for ARC Welding;
B. Properly adjust machine settings;
C. Understand basis of striking the arc electrode manipulation, and evaluating the puddle;
D. Apply the use of gas to preheat joint on mild steel plate;
E. Apply the pre-heating technique using Electrodes; and,
F. Discuss the use of other ways of preheating (Blankets, etc.).

MODULE OUTLINE:

Instructor Topics:

A. Discuss the principles and theories involved in SMAW operations
B. Emphasize safety rules for ARC Welding equipment
C. Demonstrate machine settings and basis of striking the Arc
D. Electrode manipulation and reading the puddle
E. Demonstrate knowledge of joint design and welding terms
F. Demonstrate ability to interpret drawings and blueprints, using weld symbols
G. Introduce welding variables and demonstrate their effects on weld quality
H. Demonstrate knowledge of adequate preparation of welding surfaces
I. Prepare butt joints, and tee joints, for welding
J. Increase knowledge of current industry standards and techniques
K. Identify polarity requirements using SMAW on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match SMAW electrodes to an appropriate base metal

Student Activities:

A. Demonstrate knowledge of safety rules
B. Demonstrate equipment operation and setting adjustments
C. Preheat weld surface
D. Prepare and task weld coupons
E. Understand D.C. straight and reverse polarity

WLD-L1-HO2
Preheat Joint
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
  A. Hardening for utility
  B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  A. Brine (water and sodium chloride or sodium hydroxide)
  B. Water
  C. Fused (liquid) salts
  D. Molten lead
  E. Soluble oil and water
  F. Oil
  G. Air
IV. Estimate Metal Heat Temperature by Color
  A. Use of temper color chart for tempering
  B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes

VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media

VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L1-HO3
Preheat Joint
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
  A. Imprecise method, good for rough estimates only
  B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
  A. High-carbon steels show more spark bursts than do low-carbon steels.
  B. Non-ferrous metals
    1. Aluminum
    2. Magnesium
    3. Brass
    4. Bronze
    5. Nickel
    6. Tin
    7. Others
III. Perform Rockwell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
  A. Ferrous metals
  B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

    - c. Verbally warn others of intent to arc weld
    - d. Strike an arc
    - e. Weld with stringer bead technique
    - f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
    - a. Maintain required weld quality
    - b. Maintain proper weld width uniformly
    - c. Maintain proper travel speed
    - d. Match correct oscillation for various electrodes
    - e. Match applications to weave techniques, as they apply
    - f. List the advantages and disadvantages of weave techniques
    - g. List the advantages and disadvantages of stringer techniques
    - h. Perform weld using weave technique
    - i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
    - a. Weld a dam to outline area being welded for each layer
    - b. Apply each layer neatly, straight and with good fusion throughout
    - c. Chip slag after each pass
    - d. Weld passes which over lap to crown of last weld bead
    - e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
    - a. Follow manufacturer's recommended practice
    - b. Inspect equipment and work area for safety
    - c. Assemble oxy-fuel equipment
    - d. Open fuel gas cylinder ½ turn
    - e. Open oxygen as cylinder all the way
    - f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
    - g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    - a. Make manual free hand straight line cuts
    - b. Cut manually straight lines using cutting jib
    - c. Bevel plate with manual oxy-fuel equipment
    - d. Manually cut blind holes in thick material
    - e. Manually cut sheet metal with minimal distortion

WLD-L1-HO5
Preheat Joint
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

    g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    h. Chip slag and wire brush weld
    i. Grind any lack of fusion and/or high spots
    j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Weld pipe joint
    h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Roll weld pipe
    h. Place pipe coupon on workbench in the 1G roll welding position.
    i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

- k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
- l. Visually inspect weld on the root and face sides to ASME Section 9
- m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
    - a. Measure the pipe and
    - b. Mark the cut line with a wrap around and soapstone
    - c. Cut the bevel using oxy-fuel gas equipment
    - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    - e. Use the grinder to add a root face of from 3/32" to 1/8"
    - f. Weld pipe
    - g. Tack the single V groove pipe joint with a 3/32" root opening
    - h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
    - i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    - j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    - k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    - l. Visually inspect weld on the root and face sides to ASME Section 9
    - m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
7. Produce SMAW Pipe - 6G Position
    - a. Measure the pipe
    - b. Mark the cut line with a wrap around and soapstone
    - c. Cut the bevel using oxy-fuel gas equipment
    - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    - e. Use the grinder to add a root face of from 3/32" to 1/8"
    - f. Tack the single V groove pipe joint with a 3/32" root opening
    - g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
    - h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    - i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    - j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    - k. Visually inspect weld on the root and face sides to ASME Section 9

l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9

9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L1-HO6
Preheat Joint
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    - a. Produce end preparations with oxy-fuel cutting
    - b. Produce end preparations with plasma cutting
    - c. Produce end preparations with mechanical cutting
    - d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    - a. Cut and single bevel pipe to 37 1/2°
    - b. Ground bevel face and touch up to within tolerances
    - c. Check that pipe ends are square within given tolerances
    - d. Prepare root face within given tolerances
    - e. Align pipe to within given tolerances
    - f. Set root opening to within given tolerances
    - g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    - a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    - b. Weld remainder of pipe in the 1G roll welding position with E6010
    - c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    - a. Weld using 1/8" E6010
    - b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    - c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    - d. Weld root pass to ASME Section 9 requirements
    - e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    - a. Fit and tack weld pipe to within tolerances
    - b. Place pipe in the 5G position
    - c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
    - d. Grind the finished root pass to remove high spots and any slag at weld toes

   - e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   - a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   - b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   - c. Weld remainder of pipe in 1G position using E7018
   - d. Perform low hydrogen starts and stops
   - e. Weld using stringer bead technique
   - f. Weld using weave technique
   - g Chip slag wire brush and grind as necessary to assure clean weld deposits

7. Weld Open Root Pipe - 2G Position
   - a. Use 1/8" E6010
   - b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   - c. Fit together two pipe ends to a single V edge preparation within given tolerances
   - c. Weld root pass to ASME Section 9 requirements
   - d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   - e. Weld remainder of the groove using E7018 with the stringer bead technique

8. Weld Pipe Open Root Passes All Positions Using GMAW
   - a. Set up GMAW equipment
   - b. Adjust wire feeder drive system
   - c. Adjust shielding gas system and flow rate
   - d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   - e. Set welding condition for short circuit transfer - Wire Feed Speed
   - f. Set welding condition for short circuit transfer - Voltage
   - g. Set welding condition for short circuit transfer - Tip to work Distance
   - h. Weld root using a string bead technique

9. Weld Pipe With Backing Using FCAW-G
   - a. Bevel pipe ends
   - b. Touch up bevel face with grinder
   - c. Fit and tack backing ring to one pipe end
   - d. Fit other pipe over backing ring
   - e. Adjust gap and tack in place
   - f. Adjust shielding gas flow
   - g. Adjust wire feed system
   - h. Adjust power source to procedure specification
   - i. Set wire feed speed to procedure specification
   - j. Adjust voltage to procedure specification
   - k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: **Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.**

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: **Electrical shock can be avoided by following specific safety precautions.**

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage
H. Shut off electrical power when working on welding equipment.

CAUTION: **Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.**

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: **Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.**

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: **NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.**
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L1-LW
Preheat Joint
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC	Alternating Current
DC+(DCRP)	Direct Current Reverse Polarity
DC-(DCSP)	Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

        - (1) Product design
        - (2) Material thickness
        - (3) Design strength requirements
        - (4) Welding process employed
    - b. SMAW weld joint configuration may be a:
        - (1) Lap joint
        - (2) Tee joint
        - (3) Corner joint
        - (4) Edge joint
        - (5) Butt joint with backing
        - (6) Butt joint without backing
- Step 2. Clean the areas to be welded prior to fit-up
    - a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
    - b. Remove oils and greases with a safe, suitable solvent
- Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.
- Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.
- Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

- Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.
- Step 2. Use any preheat that may be required by welding codes or company procedures.
- Step 3. Make the required weld to be defect free and pleasing in appearance.
- Step 4. Use proper weld bead placement according to the weld joint design.
    - a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
    - b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
    - c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.
- Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.
b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:
a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:
a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

Name ______________________________ Date ____________________________

WLD-L1
Preheat Joint
Self-Assessment No. 1

Circle the best answer.

1. What is the approximate temperature required for stress relief annealing of low-carbon steels?
   - A. 950°
   - B. 1000°
   - C. 1950°
   - D. 1700°
   - E. None of the above

2. What crystalline processes result from stress relief annealing?
   - A. All grains reform into softer grains
   - B. Distorted grains reform into softer grains
   - C. Ferrite grains reform into softer grains while pearlite grains are basically unaffected
   - D. Pearlite grains reform into softer grains while ferrite grains are basically unaffected
   - E. None of the above

3. Which of the following is NOT a cause of quenching cracks?
   - A. Improper quenching medium
   - B. Overheating during the austenitizing cycle
   - C. Improper quenching angle
   - D. All of the above are causes of quenching cracks
   - E. None of the above answers is correct

4. Which of the following is NOT a characteristic of typical quench cracks?
   - A. The fracture tends to run from the surface toward the center in a smooth curve
   - B. Untempered quench cracks will not show any decarburization
   - C. Tempered fracture surfaces will show a fine crystalline structure
   - D. All of the above are characteristic of quench cracks
   - E. None of the above

5. During tempering by color, which of the following colors represents the highest temperature?
   A. Gold
   B. Purple
   C. Dark Straw
   D. Pale Blue
   E. Violet

6. During tempering by color, which of the following colors represents the lowest temperature?
   A. Gold
   B. Purple
   C. Dark Straw
   D. Pale Blue
   E. Violet

7. What is meant by *step quenching*?
   A. The workpiece is first quenched in a slow medium (e.g., air) then in a fast medium (e.g., water)
   B. The workpiece is first quenched in a fast medium (e.g., water) then in a slow medium (e.g., air)
   C. The weaker parts of the workpiece are quenched separately from the main body of the workpiece
   D. The workpiece is lowered into the quenching medium in steps so that different parts of the workpiece attain different hardnesses
   E. None of the above

8. What is the simplest thing that the technician can do to minimize the vapor-blanket stage of liquid quenching?
   A. Agitate the workpiece or the medium
   B. Heat the quenching medium to just below its boiling point
   C. Quickly insert the workpiece into the medium
   D. Slowly insert the workpiece into the medium
   E. None of the above

9. Liquid carburizing, as used in case hardening, utilizes __________ and is therefore extremely dangerous.
   A. Sodium chloride
   B. Calcium carbonate
   C. Cyanide salts
   D. Ammonia
   E. None of the above

10. Workpieces which have been cut with an oxyacetylene torch often display edge hardness because

A. The torch was starved for oxygen
B. The workpiece was cut at too low a temperature
C. The wrong type of cutting torch was used
D. Oxyacetylene torches always leave hardened edges
E. None of the above

WLD-L1
Preheat Joint
Self-Assessment No. 1 Answer Key

1.	a
2.	c
3.	d
4.	a
5.	c
6.	d
7.	b
8.	a
9.	c
10.	a

Name ______________________________ Date ____________________

WLD-L1
Preheat Joint
Self-Assessment No. 2

Circle the best answer.

1. The *hardness* of a metal is its ability to resist:
   A. Permanent deformation.
   B. Oxidation.
   C. Chemical reaction.
   D. All of the above answers are forms of hardness.
   E. None of the above.

2. Rockwell testing machines test the sample metal's resistance to:
   A. Abrasion.
   B. Penetration.
   C. Elastic deformation.
   D. Electricity.
   E. None of the above.

3. Materials such as nitrided steel and hard cast irons generally have Rockwell hardness numbers in excess of
   A. B-50.
   B. B-75.
   C. B- 100.
   D. B-150.
   E. None of the above.

4. During the file test, if the file will mark the metal but not cut into it, then the metal should be treated as:
   A. High-alloy steel.
   B. Mild steel.
   C. Hardened tool steel.
   D. Medium-carbon steel.
   E. None of the above.

5. Probably the best use of the spark test is to:
   A. Determine the alloy content of the sample.
   B. Identify cast iron.
   C. Compare the sample to a known piece.
   D. All of the above answers are valid.
   E. None of the above.

6. Tool steel has a Rockwell hardness of __________, while hardened tool steel has hardness number of __________.
   A. C-42 - C-64
   B. C-42 - B-65
   C. C-64 - C-42
   D. B-65 - C-42
   E. None of the above.

7. Which of the following surfaces should be avoided when hardness testing?
   A. Curved
   B. Rough
   C. Decarburized
   D. All of the above surfaces should be modified before testing the sample's hardness.
   E. None of the above.

8. For hardness testing, the minimum recommended clearance from the edge is:
   A. 1/2"
   B. 1/4"
   C. 1/8"
   D. 1/16"
   E. None of the above.

9. If a Rockwell tester is in daily use, it should be calibrated:
   A. Annually.
   B. Monthly.
   C. Weekly.
   D. Daily.
   E. Never.

10. Technician A says that, for large samples, multiple hardness test should be made and their results averaged. Technician B says that many materials vary in hardness over the length of the sample. Who is correct?
   A. Technician A only
   B. Technician B only
   C. Both technicians are correct.
   D. Neither technician is correct.

WLD-L1
Preheat Joint
Self-Assessment No. 2 Answer Key

1. a
2. b
3. c
4. c
5. c
6. e
7. d
8. c
9. d
10. d

Name: ______________________________ Date: ___________________________

WLD-L1
Preheat Joint
Self-Assessment No. 3

Choose the best answer.

1. The size of the bead is __________ proportional to the speed of travel.
   - A. Directly
   - B. Inversely
   - C. Not
   - D. None of the above

2. The eye shield of the welding helmet should be:
   - A. Just light enough to clearly see the arc.
   - B. Too dark to clearly see the arc.
   - C. A minimum of #5.
   - D. None of the above.

3. Welding in confined spaces may require:
   - A. Air supplied hoods or hose masks.
   - B. Frequent breaks.
   - C. Large, high-displacement fans.
   - D. All of the above.
   - E. None of the above.

4. Long sleeves protect the arms against:
   - A. Ultraviolet radiation.
   - B. Infrared radiation.
   - C. Welding splatter.
   - D. All of the above.
   - E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
   - A. Current polarity
   - B. Arc length
   - C. Length of the electrode
   - D. All of the above are variables in the process.
   - E. None of the above.

6. Acceptable welding footwear includes:
   A. Roman sandals.
   B. Tennis shoes.
   C. Canvas boots.
   D. All of the above.
   E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   A. Excess convexity.
   B. Overlap.
   C. Porosity.
   D. All of the above.
   E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   A. DC-.
   B. DC+.
   C. AC.
   D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
   A. On.
   B. Off.
   C. On or off, depending on the repair.
   D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
   A. On rubber work mats.
   B. Elevated off the floor.
   C. Grounded.
   D. All of the above.
   E. None of the above.

14. Which of the following electrodes is NOT in the low-hydrogen family?
   A. E7015
   B. E7016
   C. E7018
   D. All of the above are low-hydrogen electrodes.
   E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

16. Fire inspections should be continued for at least __________ after completion of the welding.
   A. Fifteen minutes
   B. Thirty minutes
   C. One hour
   D. Two hours

17. The welding area should be:
   A. Isolated from other workers by shields.
   B. At least 35 feet from combustible materials.
   C. Dry.
   D. All of the above.
   E. None of the above.

18. Seam welds generally require ___________ oscillation.
   A. No
   B. Very little
   C. Moderate
   D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?
   A. Technician A only.
   B. Technician B only
   C. Both Technicians A and B
   D. Neither Technician A nor B

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:
   A. Do not weld
   B. Take frequent breaks to inspect the area for fires
   C. Station a fire watcher near the combustible materials
   D. Any of the above is acceptable
   E. None of the above

21. E7018 electrodes should never be used with
   A. DC-
   B. DC+
   C. AC
   D. There is no such electrode

22. Areas to be welded should be thoroughly cleaned
   A. Prior to fit-up
   B. By brushing, sanding, or grinding
   C. With safe solvents
   D. All of the above, as necessary
   E. None of the above

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?
   A. Technician A only
   B. Technician B only
   C. Both Technicians A and B
   D. Neither Technician A nor B

24. Low-hydrogen electrodes may be stored
A. In sealed cans or heated rod ovens
B. Under water
C. In petroleum jelly
D. Any of the above
E. None of the above

25. As the material being welded increases in thickness, the travel speed of the weld must
A. Increase
B. Decrease
C. Either A or B, depending on the desired effect
D. Stay the same
E. None of the above

WLD-L1

Preheat Joint

Self-Assessment No. 3 Answer Key

1.	b
2.	a
3.	a
4.	d
5.	c
6.	e
7.	e
8.	c
9.	b
10.	c
11.	c
12.	b
13.	c
14.	d
15.	a
16.	b
17.	d
18.	b
19.	c
20.	c
21.	a
22.	d
23.	b
24.	a
25.	b

WELDER SERIES
MASTER Technical Module No. WLD-L02

SUBJECT: **WELDING TECHNICIAN** **TIME: 20 HOURS**

- **DUTY:** **SHIELDED METAL ARC WELDING (SMAW) (BASIC)**
- **TASK:** Initiate Welding Process

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Apply the use of gas to preheat joint on mild steel plate;
B. Weld Pad of Beads, flat position with 6010 Electrodes, (Weave and Stringer);
C. Weld Pad of Beads (stringer), plate in vertical position, horizontal travel sing 6010 Electrodes;
D. Weld Pad of Beads (stringer), plate in vertical position, vertical travel using 6010 Electrodes;
E. Weld Pad of Beads (stringer) overhead position using 6010 Electrodes;
F. Fillet weld Multi-Stringer, horizontal travel using 6010 Electrodes;
G. Fillet weld Multi-Stringer, vertical travel using 6010 Electrodes;
H. Fillet weld Multi-Stringer, overhead using 6010 Electrodes;
I. Weld Open groove, Multi-Stringer, horizontal position using 6010 Electrodes;
J. Weld Open groove, Multi-Stringer, vertical position using 6010 Electrodes;
K. Weld Open groove, overhead position using 6010 Electrodes;
L. Weld Open groove, vertical position, 6010 root pass 7018 fill & cap;
M. Weld Open groove, overhead position 6010 root pass 7018 fill & cap; and,
N. Perform destructive testing on weld samples to determine discontinuities and proficiency.

INSTRUCTIONAL MATERIALS:

Student Workbook
Two written tests on Shielded Metal Arc Welding
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video materials
Hobart SMAW wall chart
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Shielded Metal Arc Welding machine
Welding shop tools
Selection of base metals for welding and cutting

Selection of filler metals and electrode wire
MASTER Handout No. 1 (WLD-L2-HO1)
MASTER Handout No. 2 (WLD-L2-HO2)
MASTER Handout No. 3 (WLD-L2-HO3)
MASTER Handout No. 4 (WLD-L2-HO4)
MASTER Handout No. 5 (WLD-L2-HO5)
MASTER Handout No. 6 (WLD-L2-HO6)
MASTER Laboratory Aid (WLD-L2-LA)
MASTER Laboratory Worksheet (WLD-L2-LW)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Reading Welding Blueprints & Symbols, Stinchcomb, Craig, New Jersey: Prentice-Hall, Inc., Latest Edition
Certification Manual For Welding Inspector, American Welding Society, Miami, FL, (ISBN 0-87171-421-3) Latest Edition
Welding Qualifications, Practical Guide to ASME Section IX, Houle, Michael J., *CASTI* Publishing, Inc., Canada, (ISBN 0-9696428-5-7), Latest Edition
The Procedure Handbook of Arc Welding; The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following module:

WLD-L1 "Preheat Joint"

INTRODUCTION:

The Course Introduction will Include:

- An overview of SMAW welding methods and techniques
- A class demonstration of effective welding applications for SMAW
- A discussion on continued training activities resulting in an increase of skill and knowledge leading to certification in specific program areas.

PRESENTATION OUTLINE:

Instructor Topics:

A. Emphasize the principles involved in the operating of SMAW equipment
B. Discuss fundamentals of joint design and relevance of welding terms
C. How to interpret drawings and blueprints, using SMAW
D. Demonstration of the proper application of welding skills
E. Demonstration of adequate preparation of welding surfaces
F. Prepare butt joints, and tee joints, for welding
G. Identify polarity requirements using SMAW on various metals
H. Demonstrate preheat and how to maintain desired temperature
I. Match SMAW electrodes to an appropriate base metal
J. Demonstrate SMAW in the flat horizontal, vertical, and overhead positions
K. Identify welding variables and their effects on weld quality
L. Increase knowledge of current industry standards and techniques
M. Increase skill level to pass certification tests
N. Identify the AISI steel classification system

Student Activities:

A. Preheat weld surface
B. Perform welds in multiple positions
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality
F. Perform destruction testing on weld samples

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

Two examinations will be given at the end of this section to determine the progress of the class. Practical work and welds will be evaluated by the student and the instructor.

SUMMARY:

Arc welding may be done with direct current (DC) with the electrode either positive or negative, or alternating current (AC). The choice of current and polarity depends on the process, the type of electrode, the arc atmosphere, and the metal being welded. The current must be controlled to satisfy the variables (amperage and voltage) which are specified by the welding procedures.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-L3) dealing with performing weld sequence.

WLD-L2-HO1
Initiate Welding Process
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Apply the use of gas to preheat joint on mild steel plate;
B. Weld Pad of Beads, flat position with 6010 Electrodes, (Weave and Stringer);
C. Weld Pad of Beads (stringer), plate in vertical position, horizontal travel sing 6010 Electrodes;
D. Weld Pad of Beads (stringer), plate in vertical position, vertical travel using 6010 Electrodes;
E. Weld Pad of Beads (stringer) overhead position using 6010 Electrodes;
F. Fillet weld Multi-Stringer, horizontal travel using 6010 Electrodes;
G. Fillet weld Multi-Stringer, vertical travel using 6010 Electrodes;
H. Fillet weld Multi-Stringer, overhead using 6010 Electrodes;
I. Weld Open groove, Multi-Stringer, horizontal position using 6010 Electrodes;
J. Weld Open groove, Multi-Stringer, vertical position using 6010 Electrodes;
K. Weld Open groove, overhead position using 6010 Electrodes;
L. Weld Open groove, vertical position, 6010 root pass 7018 fill & cap;
M. Weld Open groove, overhead position 6010 root pass 7018 fill & cap; and,
N. Perform destructive testing on weld samples to determine discontinuities and proficiency.

MODULE OUTLINE:

Instructor Topics:

A. Emphasize the principles involved in the operating of SMAW equipment
B. Discuss fundamentals of joint design and relevance of welding terms
C. How to interpret drawings and blueprints, using SMAW
D. Demonstration of the proper application of welding skills
E. Demonstration of adequate preparation of welding surfaces
F. Prepare butt joints, and tee joints, for welding
G. Identify polarity requirements using SMAW on various metals
H. Demonstrate preheat and how to maintain desired temperature
I. Match SMAW electrodes to an appropriate base metal
J. Demonstrate SMAW in the flat horizontal, vertical, and overhead positions
K. Identify welding variables and their effects on weld quality
L. Increase knowledge of current industry standards and techniques
M. Increase skill level to pass certification tests
N. Identify the AISI steel classification system

Student Activities:

A. Preheat weld surface

B. Perform welds in multiple positions
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality
F. Perform destruction testing on weld samples

WLD-L2-HO2
Initiate Welding Process
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
  A. Hardening for utility
  B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  A. Brine (water and sodium chloride or sodium hydroxide)
  B. Water
  C. Fused (liquid) salts
  D. Molten lead
  E. Soluble oil and water
  F. Oil
  G. Air
IV. Estimate Metal Heat Temperature by Color
  A. Use of temper color chart for tempering
  B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L2-HO3
Initiate Welding Process
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
  A. Imprecise method, good for rough estimates only
  B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
  A. High-carbon steels show more spark bursts than do low-carbon steels.
  B. Non-ferrous metals
    1. Aluminum
    2. Magnesium
    3. Brass
    4. Bronze
    5. Nickel
    6. Tin
    7. Others
III. Perform Rockwell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
  A. Ferrous metals
  B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L2-HO4
Initiate Welding Process
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

c. Verbally warn others of intent to arc weld
d. Strike an arc
e. Weld with stringer bead technique
f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    a. Make manual free hand straight line cuts
    b. Cut manually straight lines using cutting jib
    c. Bevel plate with manual oxy-fuel equipment
    d. Manually cut blind holes in thick material
    e. Manually cut sheet metal with minimal distortion

WLD-L2-HO5
Initiate Welding Process
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
   - a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
   - b. Use grinder to remove oxide larger and smooth plate
   - c. Use grinder to create root face of 3/32" to 1/8"
   - d. Tack single V groove joint with 3/32" root opening
   - e. Place joint in the 1G position
   - f. Place joint in 2G position once task is mastered
   - g. Place joint in 3G position once task is mastered
   - h. Place joint in 4G position once task is mastered
   - i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
   - j. Weld chipped side slag and the root bead is wire brushed
   - k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
   - l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
   - a Inspect area for safety
   - b Place plate flat on welding table
   - c Place 3" pipe vertically on top of plate and tacked in place
   - d Leave weld coupon in the 2F fixed position
   - c Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
   - f Visually inspect weld to AWS D1.1
   - g Fill pipe with water for 24 hours
   - h Check for leak
3. Produce SMAW Pipe - 5G Position
   - a Measure the pipe
   - b Mark the cut line with a wrap around and soapstone
   - c Cut the bevel using oxy-fuel gas equipment
   - d Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Tack the single V groove pipe joint with a 3/32" root opening

   - g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   - h. Chip slag and wire brush weld
   - i. Grind any lack of fusion and/or high spots
   - j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   - k. Visually inspect weld on the root and face sides to ASME Section 9
   - l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   - a. Measure the pipe
   - b. Mark the cut line with a wrap around and soapstone
   - c. Cut the bevel using oxy-fuel gas equipment
   - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Tack the single V groove pipe joint with a 3/32" root opening
   - g. Weld pipe joint
   - h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   - i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   - j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   - k. Visually inspect weld on the root and face sides to ASME Section 9
   - l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Roll Weld Pipe - SMAW
   - a. Measure the pipe
   - b. Mark the cut line with a wrap around and soapstone
   - c. Cut the bevel using oxy-fuel gas equipment
   - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Tack the single V groove pipe joint with a 3/32" root opening
   - g. Roll weld pipe
   - h. Place pipe coupon on workbench in the 1G roll welding position.
   - i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   - j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
l. Visually inspect weld on the root and face sides to ASME Section 9
m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
    a. Measure the pipe and
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Weld pipe
    g. Tack the single V groove pipe joint with a 3/32" root opening
    h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
    i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    l. Visually inspect weld on the root and face sides to ASME Section 9
    m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
7. Produce SMAW Pipe - 6G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
    h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L2-HO6
Initiate Welding Process
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    a. Produce end preparations with oxy-fuel cutting
    b. Produce end preparations with plasma cutting
    c. Produce end preparations with mechanical cutting
    d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    a. Cut and single bevel pipe to 37 1/2°
    b. Ground bevel face and touch up to within tolerances
    c. Check that pipe ends are square within given tolerances
    d. Prepare root face within given tolerances
    e. Align pipe to within given tolerances
    f. Set root opening to within given tolerances
    g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    b. Weld remainder of pipe in the 1G roll welding position with E6010
    c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    a. Weld using 1/8" E6010
    b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    d. Weld root pass to ASME Section 9 requirements
    e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    a. Fit and tack weld pipe to within tolerances
    b. Place pipe in the 5G position
    c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
    d. Grind the finished root pass to remove high spots and any slag at weld toes

    e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
    a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
    b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
    c. Weld remainder of pipe in 1G position using E7018
    d. Perform low hydrogen starts and stops
    e. Weld using stringer bead technique
    f. Weld using weave technique
    g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
    a. Use 1/8" E6010
    b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
    c. Fit together two pipe ends to a single V edge preparation within given tolerances
    c. Weld root pass to ASME Section 9 requirements
    d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
    e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
    a. Set up GMAW equipment
    b. Adjust wire feeder drive system
    c. Adjust shielding gas system and flow rate
    d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
    e. Set welding condition for short circuit transfer - Wire Feed Speed
    f. Set welding condition for short circuit transfer - Voltage
    g. Set welding condition for short circuit transfer - Tip to work Distance
    h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
    a. Bevel pipe ends
    b. Touch up bevel face with grinder
    c. Fit and tack backing ring to one pipe end
    d. Fit other pipe over backing ring
    e. Adjust gap and tack in place
    f. Adjust shielding gas flow
    g. Adjust wire feed system
    h. Adjust power source to procedure specification
    i. Set wire feed speed to procedure specification
    j. Adjust voltage to procedure specification
    k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L2-LA
Initiate Welding Process
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: **Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.**

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: **Electrical shock can be avoided by following specific safety precautions.**

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: **Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.**

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	Minimum Shade No.	Suggested Shade*
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L2-LW
Initiate Welding Process
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**

   Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

   Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

   Step 1. Choose the proper electrode for the job.

   NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

   The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

   Step 2 Store the electrodes properly.

   a Low-hydrogen electrodes:

   (1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

   (2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

   (3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

   NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current

DC+(DCRP) Direct Current Reverse Polarity

DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

    - (1) Product design
    - (2) Material thickness
    - (3) Design strength requirements
    - (4) Welding process employed
  - b. SMAW weld joint configuration may be a:
    - (1) Lap joint
    - (2) Tee joint
    - (3) Corner joint
    - (4) Edge joint
    - (5) Butt joint with backing
    - (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
  - a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
  - b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
  - a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
  - b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
  - c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. Troubleshoot Welding Problems

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a Type of base metal
b Thickness of base metal
c Surface condition of base metal (clean, rusty, or painted)
d Atmospheric conditions

Step 3 Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

Name ______________________________ Date ____________________________

WLD-L2
Initiate Welding Process
Self-Assessment No. 1

Circle the best answer.

1. What is the approximate temperature required for stress relief annealing of low-carbon steels?
   A. 950°
   B. 1000°
   C. 1950°
   D. 1700°
   E. None of the above

2. What crystalline processes result from stress relief annealing?
   A. All grains reform into softer grains
   B. Distorted grains reform into softer grains
   C. Ferrite grains reform into softer grains while pearlite grains are basically unaffected
   D. Pearlite grains reform into softer grains while ferrite grains are basically unaffected
   E. None of the above

3. Which of the following is NOT a cause of quenching cracks?
   A. Improper quenching medium
   B. Overheating during the austenitizing cycle
   C. Improper quenching angle
   D. All of the above are causes of quenching cracks
   E. None of the above answers is correct

4. Which of the following is NOT a characteristic of typical quench cracks?
   A. The fracture tends to run from the surface toward the center in a smooth curve
   B. Untempered quench cracks will not show any decarburization
   C. Tempered fracture surfaces will show a fine crystalline structure
   D. All of the above are characteristic of quench cracks
   E. None of the above

5. During tempering by color, which of the following colors represents the highest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

6. During tempering by color, which of the following colors represents the lowest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

7. What is meant by *step quenching*?
   - A. The workpiece is first quenched in a slow medium (e.g., air) then in a fast medium (e.g., water)
   - B. The workpiece is first quenched in a fast medium (e.g., water) then in a slow medium (e.g., air)
   - C. The weaker parts of the workpiece are quenched separately from the main body of the workpiece
   - D. The workpiece is lowered into the quenching medium in steps so that different parts of the workpiece attain different hardnesses
   - E. None of the above

8. What is the simplest thing that the technician can do to minimize the vapor-blanket stage of liquid quenching?
   - A. Agitate the workpiece or the medium
   - B. Heat the quenching medium to just below its boiling point
   - C. Quickly insert the workpiece into the medium
   - D. Slowly insert the workpiece into the medium
   - E. None of the above

9. Liquid carburizing, as used in case hardening, utilizes __________ and is therefore extremely dangerous.
   - A. Sodium chloride
   - B. Calcium carbonate
   - C. Cyanide salts
   - D. Ammonia
   - E. None of the above

10. Workpieces which have been cut with an oxyacetylene torch often display edge hardness because
   A. The torch was starved for oxygen
   B. The workpiece was cut at too low a temperature
   C. The wrong type of cutting torch was used
   D. Oxyacetylene torches always leave hardened edges
   E. None of the above

WLD-L2
Initiate Welding Process
Self-Assessment No. 1 Answer Key

1. a

2. c

3. d

4. a

5. c

6. d

7. b

8. a

9. c

10. a

Name ________________________________ Date ____________________

WLD-L2
Initiate Welding Process
Self-Assessment No. 2

Circle the best answer.

1. The *hardness* of a metal is its ability to resist:
   - A. Permanent deformation.
   - B. Oxidation.
   - C. Chemical reaction.
   - D. All of the above answers are forms of hardness.
   - E. None of the above.

2. Rockwell testing machines test the sample metal's resistance to:
   - A. Abrasion.
   - B. Penetration.
   - C. Elastic deformation.
   - D. Electricity.
   - E. None of the above.

3. Materials such as nitrided steel and hard cast irons generally have Rockwell hardness numbers in excess of
   - A. B-50.
   - B. B-75.
   - C. B- 100.
   - D. B-150.
   - E. None of the above.

4. During the file test, if the file will mark the metal but not cut into it, then the metal should be treated as:
   - A. High-alloy steel.
   - B. Mild steel.
   - C. Hardened tool steel.
   - D. Medium-carbon steel.
   - E. None of the above.

5. Probably the best use of the spark test is to:
   - A. Determine the alloy content of the sample.
   - B. Identify cast iron.
   - C. Compare the sample to a known piece.
   - D. All of the above answers are valid.
   - E. None of the above.

6. Tool steel has a Rockwell hardness of __________, while hardened tool steel has hardness number of __________.

A. C-42 - C-64
B. C-42 - B-65
C. C-64 - C-42
D. B-65 - C-42
E. None of the above.

7. Which of the following surfaces should be avoided when hardness testing?

A. Curved
B. Rough
C. Decarburized
D. All of the above surfaces should be modified before testing the sample's hardness.
E. None of the above.

8. For hardness testing, the minimum recommended clearance from the edge is:

A. 1/2"
B. 1/4"
C. 1/8"
D. 1/16"
E. None of the above.

9. If a Rockwell tester is in daily use, it should be calibrated:

A. Annually.
B. Monthly.
C. Weekly.
D. Daily.
E. Never.

10. Technician A says that, for large samples, multiple hardness test should be made and their results averaged. Technician B says that many materials vary in hardness over the length of the sample. Who is correct?

A. Technician A only
B. Technician B only
C. Both technicians are correct.
D. Neither technician is correct.

WLD-L2
Initiate Welding Process
Self-Assessment No. 2 Answer Key

1. a
2. b
3. c
4. c
5. c
6. e
7. d
8. c
9. d
10. d

Name: ______________________________ Date: ___________________________

WLD-L2
Initiate Welding Process
Self-Assessment No. 3

Choose the best answer.

1. The size of the bead is __________ proportional to the speed of travel.
    - A. Directly
    - B. Inversely
    - C. Not
    - D. None of the above

2. The eye shield of the welding helmet should be:
    - A. Just light enough to clearly see the arc.
    - B. Too dark to clearly see the arc.
    - C. A minimum of #5.
    - D. None of the above.

3. Welding in confined spaces may require:
    - A. Air supplied hoods or hose masks.
    - B. Frequent breaks.
    - C. Large, high-displacement fans.
    - D. All of the above.
    - E. None of the above.

4. Long sleeves protect the arms against:
    - A. Ultraviolet radiation.
    - B. Infrared radiation.
    - C. Welding splatter.
    - D. All of the above.
    - E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
    - A. Current polarity
    - B. Arc length
    - C. Length of the electrode
    - D. All of the above are variables in the process.
    - E. None of the above.

6. Acceptable welding footwear includes:
   - A. Roman sandals.
   - B. Tennis shoes.
   - C. Canvas boots.
   - D. All of the above.
   - E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   - A. Excess convexity.
   - B. Overlap.
   - C. Porosity.
   - D. All of the above.
   - E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   - A. Technician A only.
   - B. Technician B only.
   - C. Both Technicians A and B.
   - D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   - A. DC-.
   - B. DC+.
   - C. AC.
   - D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
    - A. Technician A only.
    - B. Technician B only.
    - C. Both Technicians A and B.
    - D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
    - A. Technician A only.
    - B. Technician B only.
    - C. Both Technicians A and B.
    - D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
   A. On.
   B. Off.
   C. On or off, depending on the repair.
   D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
   A. On rubber work mats.
   B. Elevated off the floor.
   C. Grounded.
   D. All of the above.
   E. None of the above.

14. Which of the following electrodes is NOT in the low-hydrogen family?
   A. E7015
   B. E7016
   C. E7018
   D. All of the above are low-hydrogen electrodes.
   E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

16. Fire inspections should be continued for at least __________ after completion of the welding.
   A. Fifteen minutes
   B. Thirty minutes
   C. One hour
   D. Two hours

17. The welding area should be:
   A. Isolated from other workers by shields.
   B. At least 35 feet from combustible materials.
   C. Dry.
   D. All of the above.
   E. None of the above.

18. Seam welds generally require ______________ oscillation.
   - A. No
   - B. Very little
   - C. Moderate
   - D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?
   - A. Technician A only.
   - B. Technician B only
   - C. Both Technicians A and B
   - D. Neither Technician A nor B

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:
   - A. Do not weld
   - B. Take frequent breaks to inspect the area for fires
   - C. Station a fire watcher near the combustible materials
   - D. Any of the above is acceptable
   - E. None of the above

21. E7018 electrodes should never be used with
   - A. DC-
   - B. DC+
   - C. AC
   - D. There is no such electrode

22. Areas to be welded should be thoroughly cleaned
   - A. Prior to fit-up
   - B. By brushing, sanding, or grinding
   - C. With safe solvents
   - D. All of the above, as necessary
   - E. None of the above

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?
   - A. Technician A only
   - B. Technician B only
   - C. Both Technicians A and B
   - D. Neither Technician A nor B

24. Low-hydrogen electrodes may be stored
   A. In sealed cans or heated rod ovens
   B. Under water
   C. In petroleum jelly
   D. Any of the above
   E. None of the above

25. As the material being welded increases in thickness, the travel speed of the weld must
   A. Increase
   B. Decrease
   C. Either A or B, depending on the desired effect
   D. Stay the same
   E. None of the above

WLD-L2
Initiate Welding Process
Self-Assessment No. 3 Answer Key

1. b
2. a
3. a
4. d
5. c
6. e
7. e
8. c
9. b
10. c
11. c
12. b
13. c
14. d
15. a
16. b
17. d
18. b
19. c
20. c
21. a
22. d
23. b
24. a
25. b

WELDER SERIES

MASTER Technical Module No. WLD-L03

SUBJECT: **WELDING TECHNICIAN** **TIME: 20 HOURS**

- **DUTY:** **SHIELDED METAL ARC WELDING (SMAW) (BASIC)**
- **TASK:** Perform Weld Sequence

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Weld Multi-Stringer beads on steel plate using E6010 & E7018;

B. Weld steel plate using weave technique with E6010 & E7018; and,

C. Weld steel plate with E6010 for a root pass and E7018 fill & cap.

INSTRUCTIONAL MATERIALS:

Student Workbook
Four written tests on operational procedures and welding techniques
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video materials
Hobart SMAW wall chart
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Shielded Metal Arc Welding machine
Welding shop tools
Selection of base metals for welding and cutting
Selection of filler metals and electrode wire
MASTER Handout No. 1 (WLD-L3-HO1)
MASTER Handout No. 2 (WLD-L3-HO2)
MASTER Handout No. 3 (WLD-L3-HO3)
MASTER Handout No. 4 (WLD-L3-HO4)
MASTER Handout No. 5 (WLD-L3-HO5)
MASTER Handout No. 6 (WLD-L3-HO6)
MASTER Laboratory Aid (WLD-L3-LA)
MASTER Laboratory Worksheet (WLD-L3-LW)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Reading Welding Blueprints & Symbols, Stinchcomb, Craig, New Jersey: Prentice-Hall, Inc., Latest Edition
Certification Manual For Welding Inspector, American Welding Society, Miami, FL, (ISBN 0-87171-421-3) Latest Edition
Welding Qualifications, Practical Guide to ASME Section IX, Houle, Michael J., *CASTI* Publishing, Inc., Canada, (ISBN 0-9696428-5-7), Latest Edition
The Procedure Handbook of Arc Welding; The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following modules:

WLD-L1	"Preheat Joint"
WLD-L2	"Initiate Welding Process"

INTRODUCTION:

The Course Introduction will Include:

- An overview of SMAW weld sequence and techniques
- A class demonstration of effective SMAW techniques
- A discussion on training activities resulting in an increase of skill and knowledge

leading to certification in related program areas, becoming a more valuable employee

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of SMAW equipment
B. Demonstrate knowledge of the proper application of welding skills and techniques
C. Illustrate welding techniques for the five basic welding joints
D. Demonstrate knowledge of adequate preparation of welding surfaces
E. Demonstrate preheat and how to maintain desired temperature
F. Identify welding variables and their effects on weld quality
G. Identify the AISI steel classification system
H. Match SMAW electrodes to an appropriate base metal
I. Illustrate quality weld techniques for SMAW in student exercises

Student Activities:

A. Preheat weld surface
B. Weld multiple stringer beads
C. Use weave technique
D. Use oscillating and non-oscillating welding technique
E. Perform single pass and multi-pass welds;
  1 Flat plate, stringer bead, flat position;
  2 Lap joint, Fillet weld, flat position;
  3 Edge, Stringer bead, flat position;
  4 Flat plate, Pad stinger bead, Horizontal position;
  5 Lap, Fillet weld, Vertical down position;
  6 Lap, Fillet weld, Horizontal position;
  7 "T", Multipass weave beads, Flat position;
  8 Single "Y" butt, Multipass Groove weld, horizontal position;
  9 Coupling, Fillet weld, Horizontal position;
  10 Single "V" butt, Multipass filler weld, Overhead position;
  11 Square butt, Bead groove weld, Overhead position;
  12 Single "V" butt, Multipass groove weld, Horizontal position;
  13 Single "V" butt, Multipass groove weld, Overhead position.

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible and will continue until satisfactory welds are completed.

EVALUATION AND/OR VERIFICATION:

Written examinations will be given in this module to determine student progress. Each weld exercise will be evaluated by student and instructor. Students will match SMAW electrodes to the base metal.

SUMMARY:

Emphasis is on welding multi-stringer beads on steel plate, use of weave technique, and making weld adjustment to improve weld quality. The AISI steel classification system will assist students in selection of appropriate SMAW electrodes. For welding on steel plate, welders may use DCEN for best performance on all applications except when arc blow is a problem. To control arc blow, use AC. For flat and downhill use stringer beads for the first pass except when poor fitup requires a slight weave. For vertical-down, use stringer beads or a slight weave. A drag technique must be used with some E6012 electrodes. Make small beads. Point the electrode upward so that arc force pushes molten metal back up the joint. For vertical-up, use a triangular weave. Weld a shelf at the bottom of the joint and add layer upon layer. For overhead, make stringer beads using a whipping technique with a slight circular motion in the crater. Do not weave.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-L4) dealing with controlling weld technique.

WLD-L3-HO1
Perform Weld Sequence
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Weld Multi-Stringer beads on steel plate using E6010 & E7018;
B. Weld steel plate using weave technique with E6010 & E7018; and,
C. Weld steel plate with E6010 for a root pass and E7018 fill & cap.

PRESENTATION OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of SMAW equipment
B. Demonstrate knowledge of the proper application of welding skills and techniques
C. Illustrate welding techniques for the five basic welding joints
D. Demonstrate knowledge of adequate preparation of welding surfaces
E. Demonstrate preheat and how to maintain desired temperature
F. Identify welding variables and their effects on weld quality
G. Identify the AISI steel classification system
H. Match SMAW electrodes to an appropriate base metal
I. Illustrate quality weld techniques for SMAW in student exercises

Student Activities:

A. Preheat weld surface
B. Weld multiple stringer beads
C. Use weave technique
D. Use oscillating and non-oscillating welding technique
E. Perform single pass and multi-pass welds;
    1. Flat plate, stringer bead, flat position;
    2. Lap joint, Fillet weld, flat position;
    3. Edge, Stringer bead, flat position;
    4. Flat plate, Pad stinger bead, Horizontal position;
    5. Lap, Fillet weld, Vertical down position;
    6. Lap, Fillet weld, Horizontal position;
    7. "T", Multipass weave beads, Flat position;
    8. Single "Y" butt, Multipass Groove weld, horizontal position;
    9. Coupling, Fillet weld, Horizontal position;
    10. Single "V" butt, Multipass filler weld, Overhead position;
    11. Square butt, Bead groove weld, Overhead position;
    12. Single "V" butt, Multipass groove weld, Horizontal position;
    13. Single "V" butt, Multipass groove weld, Overhead position.

WLD-L3-HO2
Perform Weld Sequence
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I Discuss the Reasons for Heat Treating
  A. Hardening for utility
  B. Tempering for toughness without brittleness
II Discuss the Time/Temperature Chart
III List the Different Quenching Media (In order of *severity* or speed of quenching)
  A. Brine (water and sodium chloride or sodium hydroxide)
  B. Water
  C. Fused (liquid) salts
  D. Molten lead
  E. Soluble oil and water
  F. Oil
  G. Air
IV Estimate Metal Heat Temperature by Color
  A. Use of temper color chart for tempering
  B. *Chicken Wire* markings warn of overheating

Temperature (F)	**Temperature (C)**	**Oxide Color**	**Suggested Uses**
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

1150

V. List Reasons for Stress Relieving Workpieces
    A. Increased machinability
    B. Increased workability in cold processes

VI. Special Safety Concerns of Heat Treating
    A. Protective Gear against . . .
        1. Heat
        2. Fumes
        3. Concussion
    B. Toxicity of Certain Media

VII. Special Problems in Heat Treating
    A. Brittleness
    B. Distortion
    C. Discoloration (sometimes unimportant)
    D. Inadvertent heat treating

WLD-L3-HO3
Perform Weld Sequence
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
    A. Imprecise method, good for rough estimates only
    B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
    A. High-carbon steels show more spark bursts than do low-carbon steels.
    B. Non-ferrous metals
        1. Aluminum
        2. Magnesium
        3. Brass
        4. Bronze
        5. Nickel
        6. Tin
        7. Others
III. Perform Rockwell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
    A. Ferrous metals
    B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L3-HO4
Perform Weld Sequence
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

    c. Verbally warn others of intent to arc weld
    d. Strike an arc
    e. Weld with stringer bead technique
    f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
    a. Maintain required weld quality
    b. Maintain proper weld width uniformly
    c. Maintain proper travel speed
    d. Match correct oscillation for various electrodes
    e. Match applications to weave techniques, as they apply
    f. List the advantages and disadvantages of weave techniques
    g. List the advantages and disadvantages of stringer techniques
    h. Perform weld using weave technique
    i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
    a. Weld a dam to outline area being welded for each layer
    b. Apply each layer neatly, straight and with good fusion throughout
    c. Chip slag after each pass
    d. Weld passes which over lap to crown of last weld bead
    e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
    a. Follow manufacturer's recommended practice
    b. Inspect equipment and work area for safety
    c. Assemble oxy-fuel equipment
    d. Open fuel gas cylinder ½ turn
    e. Open oxygen as cylinder all the way
    f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
    g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    a. Make manual free hand straight line cuts
    b. Cut manually straight lines using cutting jib
    c. Bevel plate with manual oxy-fuel equipment
    d. Manually cut blind holes in thick material
    e. Manually cut sheet metal with minimal distortion

WLD-L3-HO5
Perform Weld Sequence
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
h. Chip slag and wire brush weld
i. Grind any lack of fusion and/or high spots
j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
k. Visually inspect weld on the root and face sides to ASME Section 9
l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Weld pipe joint
   h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Roll weld pipe
   h. Place pipe coupon on workbench in the 1G roll welding position.
   i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
l. Visually inspect weld on the root and face sides to ASME Section 9
m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L3-HO6
Perform Weld Sequence
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    a. Produce end preparations with oxy-fuel cutting
    b. Produce end preparations with plasma cutting
    c. Produce end preparations with mechanical cutting
    d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    a. Cut and single bevel pipe to 37 1/2°
    b. Ground bevel face and touch up to within tolerances
    c. Check that pipe ends are square within given tolerances
    d. Prepare root face within given tolerances
    e. Align pipe to within given tolerances
    f. Set root opening to within given tolerances
    g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    b. Weld remainder of pipe in the 1G roll welding position with E6010
    c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    a. Weld using 1/8" E6010
    b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    d. Weld root pass to ASME Section 9 requirements
    e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    a. Fit and tack weld pipe to within tolerances
    b. Place pipe in the 5G position
    c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
    d. Grind the finished root pass to remove high spots and any slag at weld toes

   e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   c. Weld remainder of pipe in 1G position using E7018
   d. Perform low hydrogen starts and stops
   e. Weld using stringer bead technique
   f. Weld using weave technique
   g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   a. Use 1/8" E6010
   b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   c. Fit together two pipe ends to a single V edge preparation within given tolerances
   c. Weld root pass to ASME Section 9 requirements
   d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
   a Set up GMAW equipment
   b Adjust wire feeder drive system
   c Adjust shielding gas system and flow rate
   d Adjust GMAW gun to allow proper tip to work distance and gas coverage
   e Set welding condition for short circuit transfer - Wire Feed Speed
   f Set welding condition for short circuit transfer - Voltage
   g Set welding condition for short circuit transfer - Tip to work Distance
   h Weld root using a string bead technique
9 Weld Pipe With Backing Using FCAW-G
   a Bevel pipe ends
   b Touch up bevel face with grinder
   c Fit and tack backing ring to one pipe end
   d Fit other pipe over backing ring
   e Adjust gap and tack in place
   f Adjust shielding gas flow
   g Adjust wire feed system
   h Adjust power source to procedure specification
   i. Set wire feed speed to procedure specification
   j. Adjust voltage to procedure specification
   k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current

DC+(DCRP) Direct Current Reverse Polarity

DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	**Current Range (amp)**								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

(1) Product design
(2) Material thickness
(3) Design strength requirements
(4) Welding process employed

b. SMAW weld joint configuration may be a:

(1) Lap joint
(2) Tee joint
(3) Corner joint
(4) Edge joint
(5) Butt joint with backing
(6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up

a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing

b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.

a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.

b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.

c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

Name ______________________________ Date ____________________________

WLD-L3
Perform Weld Sequence
Self-Assessment No. 1

Circle the best answer.

1. What is the approximate temperature required for stress relief annealing of low-carbon steels?
    A. 950°
    B. 1000°
    C. 1950°
    D. 1700°
    E. None of the above

2. What crystalline processes result from stress relief annealing?
    A. All grains reform into softer grains
    B. Distorted grains reform into softer grains
    C. Ferrite grains reform into softer grains while pearlite grains are basically unaffected
    D. Pearlite grains reform into softer grains while ferrite grains are basically unaffected
    E. None of the above

3. Which of the following is NOT a cause of quenching cracks?
    A. Improper quenching medium
    B. Overheating during the austenitizing cycle
    C. Improper quenching angle
    D. All of the above are causes of quenching cracks
    E. None of the above answers is correct

4. Which of the following is NOT a characteristic of typical quench cracks?
    A. The fracture tends to run from the surface toward the center in a smooth curve
    B. Untempered quench cracks will not show any decarburization
    C. Tempered fracture surfaces will show a fine crystalline structure
    D. All of the above are characteristic of quench cracks
    E. None of the above

5. During tempering by color, which of the following colors represents the highest temperature?
   A. Gold
   B. Purple
   C. Dark Straw
   D. Pale Blue
   E. Violet

6. During tempering by color, which of the following colors represents the lowest temperature?
   A. Gold
   B. Purple
   C. Dark Straw
   D. Pale Blue
   E. Violet

7. What is meant by *step quenching*?
   A. The workpiece is first quenched in a slow medium (e.g., air) then in a fast medium (e.g., water)
   B. The workpiece is first quenched in a fast medium (e.g., water) then in a slow medium (e.g., air)
   C. The weaker parts of the workpiece are quenched separately from the main body of the workpiece
   D. The workpiece is lowered into the quenching medium in steps so that different parts of the workpiece attain different hardnesses
   E. None of the above

8. What is the simplest thing that the technician can do to minimize the vapor-blanket stage of liquid quenching?
   A. Agitate the workpiece or the medium
   B. Heat the quenching medium to just below its boiling point
   C. Quickly insert the workpiece into the medium
   D. Slowly insert the workpiece into the medium
   E. None of the above

9. Liquid carburizing, as used in case hardening, utilizes __________ and is therefore extremely dangerous.
   A. Sodium chloride
   B. Calcium carbonate
   C. Cyanide salts
   D. Ammonia
   E. None of the above

10. Workpieces which have been cut with an oxyacetylene torch often display edge hardness because

A. The torch was starved for oxygen
B. The workpiece was cut at too low a temperature
C. The wrong type of cutting torch was used
D. Oxyacetylene torches always leave hardened edges
E. None of the above

WLD-L3
Perform Weld Sequence
Self-Assessment No. 1 Answer Key

1. a
2. c
3. d
4. a
5. c
6. d
7. b
8. a
9. c
10. a

Name ______________________________ Date ____________________

WLD-L3
Perform Weld Sequence
Self-Assessment No. 2

Circle the best answer.

1. The *hardness* of a metal is its ability to resist:
   - A. Permanent deformation.
   - B. Oxidation.
   - C. Chemical reaction.
   - D. All of the above answers are forms of hardness.
   - E. None of the above.

2. Rockwell testing machines test the sample metal's resistance to:
   - A. Abrasion.
   - B. Penetration.
   - C. Elastic deformation.
   - D. Electricity.
   - E. None of the above.

3. Materials such as nitrided steel and hard cast irons generally have Rockwell hardness numbers in excess of
   - A. B-50.
   - B. B-75.
   - C. B- 100.
   - D. B-150.
   - E. None of the above.

4. During the file test, if the file will mark the metal but not cut into it, then the metal should be treated as:
   - A. High-alloy steel.
   - B. Mild steel.
   - C. Hardened tool steel.
   - D. Medium-carbon steel.
   - E. None of the above.

5. Probably the best use of the spark test is to:
   - A. Determine the alloy content of the sample.
   - B. Identify cast iron.
   - C. Compare the sample to a known piece.
   - D. All of the above answers are valid.
   - E. None of the above.

6. Tool steel has a Rockwell hardness of __________, while hardened tool steel has hardness number of __________.
   A. C-42 - C-64
   B. C-42 - B-65
   C. C-64 - C-42
   D. B-65 - C-42
   E. None of the above.

7. Which of the following surfaces should be avoided when hardness testing?
   A. Curved
   B. Rough
   C. Decarburized
   D. All of the above surfaces should be modified before testing the sample's hardness.
   E. None of the above.

8. For hardness testing, the minimum recommended clearance from the edge is:
   A. 1/2"
   B. 1/4"
   C. 1/8"
   D. 1/16"
   E. None of the above.

9. If a Rockwell tester is in daily use, it should be calibrated:
   A. Annually.
   B. Monthly.
   C. Weekly.
   D. Daily.
   E. Never.

10. Technician A says that, for large samples, multiple hardness test should be made and their results averaged. Technician B says that many materials vary in hardness over the length of the sample. Who is correct?
   A. Technician A only
   B. Technician B only
   C. Both technicians are correct.
   D. Neither technician is correct.

WLD-L3
Perform Weld Sequence
Self-Assessment No. 2 Answer Key

1. a

2. b

3. c

4. c

5. c

6. e

7. d

8. c

9. d

10. d

Name: ______________________________ Date: __________________________

WLD-L3
Perform Weld Sequence
Self-Assessment No. 3

Choose the best answer.

1. The size of the bead is __________ proportional to the speed of travel.
   - A. Directly
   - B. Inversely
   - C. Not
   - D. None of the above

2. The eye shield of the welding helmet should be:
   - A. Just light enough to clearly see the arc.
   - B. Too dark to clearly see the arc.
   - C. A minimum of #5.
   - D. None of the above.

3. Welding in confined spaces may require:
   - A. Air supplied hoods or hose masks.
   - B. Frequent breaks.
   - C. Large, high-displacement fans.
   - D. All of the above.
   - E. None of the above.

4. Long sleeves protect the arms against:
   - A. Ultraviolet radiation.
   - B. Infrared radiation.
   - C. Welding splatter.
   - D. All of the above.
   - E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
   - A. Current polarity
   - B. Arc length
   - C. Length of the electrode
   - D. All of the above are variables in the process.
   - E. None of the above.

6. Acceptable welding footwear includes:
   A. Roman sandals.
   B. Tennis shoes.
   C. Canvas boots.
   D. All of the above.
   E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   A. Excess convexity.
   B. Overlap.
   C. Porosity.
   D. All of the above.
   E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   A. DC-.
   B. DC+.
   C. AC.
   D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct? •
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
    A. On.
    B. Off.
    C. On or off, depending on the repair.
    D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
    A. On rubber work mats.
    B. Elevated off the floor.
    C. Grounded.
    D. All of the above.
    E. None of the above.

14. Which of the following electrodes is NOT in the low-hydrogen family?
    A. E7015
    B. E7016
    C. E7018
    D. All of the above are low-hydrogen electrodes.
    E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

16. Fire inspections should be continued for at least __________ after completion of the welding
    A. Fifteen minutes
    B. Thirty minutes
    C. One hour
    D. Two hours

17. The welding area should be:
    A. Isolated from other workers by shields.
    B. At least 35 feet from combustible materials.
    C. Dry
    D. All of the above.
    E. None of the above.

18. Seam welds generally require _____________ oscillation.
   A. No
   B. Very little
   C. Moderate
   D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?
   A. Technician A only.
   B. Technician B only
   C. Both Technicians A and B
   D. Neither Technician A nor B

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:
   A. Do not weld
   B. Take frequent breaks to inspect the area for fires
   C. Station a fire watcher near the combustible materials
   D. Any of the above is acceptable
   E. None of the above

21. E7018 electrodes should never be used with
   A. DC-
   B. DC+
   C. AC
   D. There is no such electrode

22. Areas to be welded should be thoroughly cleaned
   A. Prior to fit-up
   B. By brushing, sanding, or grinding
   C. With safe solvents
   D. All of the above, as necessary
   E. None of the above

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?
   A. Technician A only
   B. Technician B only
   C. Both Technicians A and B
   D. Neither Technician A nor B

24. Low-hydrogen electrodes may be stored
   A. In sealed cans or heated rod ovens
   B. Under water
   C. In petroleum jelly
   D. Any of the above
   E. None of the above

25. As the material being welded increases in thickness, the travel speed of the weld must
   A. Increase
   B. Decrease
   C. Either A or B, depending on the desired effect
   D. Stay the same
   E. None of the above

WLD-L3
Perform Weld Sequence
Self-Assessment No. 3 Answer Key

1. b
2. a
3. a
4. d
5. c
6. e
7. e
8. c
9. b
10. c
11. c
12. b
13. c
14. d
15. a
16. b
17. d
18. b
19. c
20. c
21. a
22. d
23. b
24. a
25. b

WELDER SERIES

MASTER Technical Module No. WLD-L04

SUBJECT: WELDING TECHNICIAN TIME: 12 HOURS

- **DUTY: SHIELDED METAL ARC WELDING (SMAW) (BASIC)**
- **TASK:** Control Weld Technique

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Use proper welding techniques for light gage metals;
B. Demonstrate proper methods of welding materials of different thickness into a lap joint;
C. Use iron powder or heavy coated electrodes, understand the use and advantage of low hydrogen electrodes; and,
D. Control movement pattern and width of each bead on the overhead position Tee joint using low hydrogen electrodes.

INSTRUCTIONAL MATERIALS:

Student Workbook
Two written tests on SMAW welding techniques in this module
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video materials
Hobart SMAW wall chart
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Shielded Metal Arc Welding machine
Welding shop tools
Selection of base metals for welding and cutting
Selection of filler metals and electrode wire
MASTER Handout No. 1 (WLD-L4-HO1)
MASTER Handout No. 2 (WLD-L4-HO2)
MASTER Handout No. 3 (WLD-L4-HO3)
MASTER Handout No. 4 (WLD-L4-HO4)
MASTER Handout No. 5 (WLD-L4-HO5)
MASTER Handout No. 6 (WLD-L4-HO6)
MASTER Laboratory Aid (WLD-L4-LA)
MASTER Laboratory Worksheet (WLD-L4-LW)
MASTER Self-Assessment No. 1

MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Reading Welding Blueprints & Symbols, Stinchcomb, Craig, New Jersey: Prentice-Hall, Inc., Latest Edition
Certification Manual For Welding Inspector, American Welding Society, Miami, FL, (ISBN 0-87171-421-3) Latest Edition
Welding Qualifications, Practical Guide to ASME Section IX, Houle, Michael J., *CASTI* Publishing, Inc., Canada, (ISBN 0-9696428-5-7), Latest Edition
The Procedure Handbook of Arc Welding; The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following modules:

WLD-L1	"Preheat Joint"
WLD-L2	"Initiate Welding Process"
WLD-L3	"Perform Weld Sequence"

INTRODUCTION:

The Course Introduction will Include:

- An overview of welding techniques for light gage metals
- A class demonstration of the use of special purpose electrodes
- A discussion on training activities leading to an increase of skill and knowledge leading to certification in related program areas.

PRESENTATION OUTLINE:

Instructor Topics:

A. Welding technique for light gage metals
B. Proper methods of welding metals of different thickness into a lap joint
C. Use of iron powder or heavy coated electrodes
D. The advantages of low hydrogen electrodes and its applications
E. Proper manipulation of the low hydrogen electrode to make a sound multipass filler in the vertical position
F. To teach control of the movement pattern and width of each bead on the overhead position tee joint, using low hydrogen electrodes
G. To teach the ability to adjust current while welding sheet steel

Student Activities:

Perform the following:

A. Fillet Weld, Lap and Tee Joints Flat and Vertical
B. Fillet Weld, Lap Joint, Vertical Down Position
C. Fillet Weld, Lap Joint, Horizontal Position
D. Fillet Weld, Tee Joint, Vertical Up Position
E. Fillet Weld, Tee Joint, Overhead Position
F. Adjust current while welding sheet steel

PRACTICAL APPLICATION:

The student will gain knowledge and experience with steel plate and sheet steel.

EVALUATION AND/OR VERIFICATION:

Written examinations will be given in this module to determine student progress. Welding exercises will be evaluated by student and instructor. Student will continue practice until found proficient.

SUMMARY:

Student understanding, practice, and proper adjustments lead to proficiency with SMAW techniques. The ability to adjust current while welding sheet steel is helpful, particularly when fitup or material thickness varies. Motor generator welders equipped with foot operated remote current controls are useful for this purpose.

Generally welders may use the highest current that does not cause melt-through, does not undercut, or does not melt the edges of lap, corner or edge welds. For fast welding, the operator must stay precisely on the joint and must travel at uniform speed. Welding on sheet metal requires skill and a new welder may require considerable practice to become proficient.

Conventional welding electrodes may not be suitable where the base metal has a tendency to crack, where thick sections are to be welded, or where the base metal has an alloy content higher than mild steel. For these applications a low hydrogen electrode may be required. These reduce the danger of underbeads and microcracking on thick weldments.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-L5) dealing with maintaining preheat.

WLD-L4-HO1
Control Weld Technique
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Use proper welding techniques for light gage metals;
B. Demonstrate proper methods of welding materials of different thickness into a lap joint;
C. Use iron powder or heavy coated electrodes, understand the use and advantage of low hydrogen electrodes; and,
D. Control movement pattern and width of each bead on the overhead position Tee joint using low hydrogen electrodes.

MODULE OUTLINE:

Instructor Topics:
A. Welding technique for light gage metals
B. Proper methods of welding metals of different thickness into a lap joint
C. Use of iron powder or heavy coated electrodes
D. The advantages of low hydrogen electrodes and its applications
E. Proper manipulation of the low hydrogen electrode to make a sound multipass filler in the vertical position
F. To teach control of the movement pattern and width of each bead on the overhead position tee joint, using low hydrogen electrodes
G. To teach the ability to adjust current while welding sheet steel

Student Activities:
Perform the following:
A. Fillet Weld, Lap and Tee Joints Flat and Vertical
B. Fillet Weld, Lap Joint, Vertical Down Position
C. Fillet Weld, Lap Joint, Horizontal Position
D. Fillet Weld, Tee Joint, Vertical Up Position
E. Fillet Weld, Tee Joint, Overhead Position
F. Adjust current while welding sheet steel

WLD-L4-HO2
Control Weld Technique
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
   A. Hardening for utility
   B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
   A. Brine (water and sodium chloride or sodium hydroxide)
   B. Water
   C. Fused (liquid) salts
   D. Molten lead
   E. Soluble oil and water
   F. Oil
   G. Air
IV. Estimate Metal Heat Temperature by Color
   A. Use of temper color chart for tempering
   B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

- V. List Reasons for Stress Relieving Workpieces
    - A. Increased machinability
    - B. Increased workability in cold processes
- VI. Special Safety Concerns of Heat Treating
    - A. Protective Gear against . . .
        - 1. Heat
        - 2. Fumes
        - 3. Concussion
    - B. Toxicity of Certain Media
- VII. Special Problems in Heat Treating
    - A. Brittleness
    - B. Distortion
    - C. Discoloration (sometimes unimportant)
    - D. Inadvertent heat treating

WLD-L4-HO3
Control Weld Technique
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- a. Perform file test to test for metal hardness;
- b. Use other tests to identify metals; and,
- c. Perform Rockwell hardness tests.

MODULE OUTLINE:

- I. Perform File Test to Test for Metal Hardness
  - A. Imprecise method, good for rough estimates only
  - B. Requires more experienced machinist
- II. Use Other Tests to Identify Metals
  - A. High-carbon steels show more spark bursts than do low-carbon steels.
  - B. Non-ferrous metals
    - 1. Aluminum
    - 2. Magnesium
    - 3. Brass
    - 4. Bronze
    - 5. Nickel
    - 6. Tin
    - 7. Others
- III. Perform Rockwell Hardness Tests
  - A. Ferrous metals
  - B. Non-ferrous metals
- IV. Perform Brinell Hardness Tests
  - A. Ferrous metals
  - B. Non-ferrous metals
- V. Other Hardness Tests as Specified by the Instructor
  - A. Ferrous metals
  - B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L4-HO4
Control Weld Technique
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

    c. Verbally warn others of intent to arc weld
    d. Strike an arc
    e. Weld with stringer bead technique
    f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
    a. Maintain required weld quality
    b. Maintain proper weld width uniformly
    c. Maintain proper travel speed
    d. Match correct oscillation for various electrodes
    e. Match applications to weave techniques, as they apply
    f. List the advantages and disadvantages of weave techniques
    g. List the advantages and disadvantages of stringer techniques
    h. Perform weld using weave technique
    i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
    a. Weld a dam to outline area being welded for each layer
    b. Apply each layer neatly, straight and with good fusion throughout
    c. Chip slag after each pass
    d. Weld passes which over lap to crown of last weld bead
    e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
    a. Follow manufacturer's recommended practice
    b. Inspect equipment and work area for safety
    c. Assemble oxy-fuel equipment
    d. Open fuel gas cylinder ½ turn
    e. Open oxygen as cylinder all the way
    f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
    g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    a. Make manual free hand straight line cuts
    b. Cut manually straight lines using cutting jib
    c. Bevel plate with manual oxy-fuel equipment
    d. Manually cut blind holes in thick material
    e. Manually cut sheet metal with minimal distortion

WLD-L4-HO5
Control Weld Technique
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

- g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
- h. Chip slag and wire brush weld
- i. Grind any lack of fusion and/or high spots
- j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
- k. Visually inspect weld on the root and face sides to ASME Section 9
- l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   - a. Measure the pipe
   - b. Mark the cut line with a wrap around and soapstone
   - c. Cut the bevel using oxy-fuel gas equipment
   - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Tack the single V groove pipe joint with a 3/32" root opening
   - g. Weld pipe joint
   - h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   - i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   - j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   - k. Visually inspect weld on the root and face sides to ASME Section 9
   - l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
   - a. Measure the pipe
   - b. Mark the cut line with a wrap around and soapstone
   - c. Cut the bevel using oxy-fuel gas equipment
   - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Tack the single V groove pipe joint with a 3/32" root opening
   - g. Roll weld pipe
   - h. Place pipe coupon on workbench in the 1G roll welding position.
   - i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   - j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

    k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    l. Visually inspect weld on the root and face sides to ASME Section 9
    m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
    a. Measure the pipe and
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Weld pipe
    g. Tack the single V groove pipe joint with a 3/32" root opening
    h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
    i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    l. Visually inspect weld on the root and face sides to ASME Section 9
    m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
    h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L4-HO6
Control Weld Technique
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
   a. Produce end preparations with oxy-fuel cutting
   b. Produce end preparations with plasma cutting
   c. Produce end preparations with mechanical cutting
   d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
   a. Cut and single bevel pipe to 37 1/2°
   b. Ground bevel face and touch up to within tolerances
   c. Check that pipe ends are square within given tolerances
   d. Prepare root face within given tolerances
   e. Align pipe to within given tolerances
   f. Set root opening to within given tolerances
   g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
   a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   b. Weld remainder of pipe in the 1G roll welding position with E6010
   c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   a. Weld using 1/8" E6010
   b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   d. Weld root pass to ASME Section 9 requirements
   e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
   a. Fit and tack weld pipe to within tolerances
   b. Place pipe in the 5G position
   c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
   d. Grind the finished root pass to remove high spots and any slag at weld toes

   e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   c. Weld remainder of pipe in 1G position using E7018
   d. Perform low hydrogen starts and stops
   e. Weld using stringer bead technique
   f. Weld using weave technique
   g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   a. Use 1/8" E6010
   b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   c. Fit together two pipe ends to a single V edge preparation within given tolerances
   c. Weld root pass to ASME Section 9 requirements
   d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
   a. Set up GMAW equipment
   b. Adjust wire feeder drive system
   c. Adjust shielding gas system and flow rate
   d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   e. Set welding condition for short circuit transfer - Wire Feed Speed
   f. Set welding condition for short circuit transfer - Voltage
   g. Set welding condition for short circuit transfer - Tip to work Distance
   h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
   a. Bevel pipe ends
   b. Touch up bevel face with grinder
   c. Fit and tack backing ring to one pipe end
   d. Fit other pipe over backing ring
   e. Adjust gap and tack in place
   f. Adjust shielding gas flow
   g. Adjust wire feed system
   h. Adjust power source to procedure specification
   i. Set wire feed speed to procedure specification
   j. Adjust voltage to procedure specification
   k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L4-LA

Control Weld Technique

Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: **Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.**

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: **Electrical shock can be avoided by following specific safety precautions.**

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: **Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.**

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	Minimum Shade No.	Suggested Shade*
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: **NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.**
DON'T CARRY A BOMB IN YOUR POCKET.

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:
AC Alternating Current
DC+(DCRP) Direct Current Reverse Polarity
DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	**Current Range (amp)**								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. **Prepare Weldment for Welding**

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

        - (1) Product design
        - (2) Material thickness
        - (3) Design strength requirements
        - (4) Welding process employed
    - b. SMAW weld joint configuration may be a:
        - (1) Lap joint
        - (2) Tee joint
        - (3) Corner joint
        - (4) Edge joint
        - (5) Butt joint with backing
        - (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
- a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
- b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
- a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
- b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
- c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.
b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

Name ______________________________ Date ______________________________

WLD-L4
Control Weld Technique
Self-Assessment No. 1

Circle the best answer.

1. What is the approximate temperature required for stress relief annealing of low-carbon steels?
   - A. 950°
   - B. 1000°
   - C. 1950°
   - D. 1700°
   - E. None of the above

2. What crystalline processes result from stress relief annealing?
   - A. All grains reform into softer grains
   - B. Distorted grains reform into softer grains
   - C. Ferrite grains reform into softer grains while pearlite grains are basically unaffected
   - D. Pearlite grains reform into softer grains while ferrite grains are basically unaffected
   - E. None of the above

3. Which of the following is NOT a cause of quenching cracks?
   - A. Improper quenching medium
   - B. Overheating during the austenitizing cycle
   - C. Improper quenching angle
   - D. All of the above are causes of quenching cracks
   - E. None of the above answers is correct

4. Which of the following is NOT a characteristic of typical quench cracks?
   - A. The fracture tends to run from the surface toward the center in a smooth curve
   - B. Untempered quench cracks will not show any decarburization
   - C. Tempered fracture surfaces will show a fine crystalline structure
   - D. All of the above are characteristic of quench cracks
   - E. None of the above

5. During tempering by color, which of the following colors represents the highest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

6. During tempering by color, which of the following colors represents the lowest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

7. What is meant by *step quenching*?
   - A. The workpiece is first quenched in a slow medium (e.g., air) then in a fast medium (e.g., water)
   - B. The workpiece is first quenched in a fast medium (e.g., water) then in a slow medium (e.g., air)
   - C. The weaker parts of the workpiece are quenched separately from the main body of the workpiece
   - D. The workpiece is lowered into the quenching medium in steps so that different parts of the workpiece attain different hardnesses
   - E. None of the above

8. What is the simplest thing that the technician can do to minimize the vapor-blanket stage of liquid quenching?
   - A. Agitate the workpiece or the medium
   - B. Heat the quenching medium to just below its boiling point
   - C. Quickly insert the workpiece into the medium
   - D. Slowly insert the workpiece into the medium
   - E. None of the above

9. Liquid carburizing, as used in case hardening, utilizes __________ and is therefore extremely dangerous.
   - A. Sodium chloride
   - B. Calcium carbonate
   - C. Cyanide salts
   - D. Ammonia
   - E. None of the above

10. Workpieces which have been cut with an oxyacetylene torch often display edge hardness because
   A. The torch was starved for oxygen
   B. The workpiece was cut at too low a temperature
   C. The wrong type of cutting torch was used
   D. Oxyacetylene torches always leave hardened edges
   E. None of the above

WLD-L4
Control Weld Technique
Self-Assessment No. 1 Answer Key

1. a

2. c

3. d

4. a

5. c

6. d

7. b

8. a

9. c

10. a

Name ______________________________ Date ____________________

WLD-L4
Control Weld Technique
Self-Assessment No. 2

Circle the best answer.

1. The *hardness* of a metal is its ability to resist:
   - A. Permanent deformation.
   - B. Oxidation.
   - C. Chemical reaction.
   - D. All of the above answers are forms of hardness.
   - E. None of the above.

2. Rockwell testing machines test the sample metal's resistance to:
   - A. Abrasion.
   - B. Penetration.
   - C. Elastic deformation.
   - D. Electricity.
   - E. None of the above.

3. Materials such as nitrided steel and hard cast irons generally have Rockwell hardness numbers in excess of
   - A. B-50.
   - B. B-75.
   - C. B- 100.
   - D. B-150.
   - E. None of the above.

4. During the file test, if the file will mark the metal but not cut into it, then the metal should be treated as:
   - A. High-alloy steel.
   - B. Mild steel.
   - C. Hardened tool steel.
   - D. Medium-carbon steel.
   - E. None of the above.

5. Probably the best use of the spark test is to:
   - A. Determine the alloy content of the sample.
   - B. Identify cast iron.
   - C. Compare the sample to a known piece.
   - D. All of the above answers are valid.
   - E. None of the above.

6. Tool steel has a Rockwell hardness of __________, while hardened tool steel has hardness number of __________.

A. C-42 - C-64
B. C-42 - B-65
C. C-64 - C-42
D. B-65 - C-42
E. None of the above.

7. Which of the following surfaces should be avoided when hardness testing?

A. Curved
B. Rough
C. Decarburized
D. All of the above surfaces should be modified before testing the sample's hardness.
E. None of the above.

8. For hardness testing, the minimum recommended clearance from the edge is:

A. 1/2”
B. 1/4”
C. 1/8”
D. 1/16”
E. None of the above.

9. If a Rockwell tester is in daily use, it should be calibrated:

A. Annually.
B. Monthly.
C. Weekly.
D. Daily.
E. Never.

10. Technician A says that, for large samples, multiple hardness test should be made and their results averaged. Technician B says that many materials vary in hardness over the length of the sample. Who is correct?

A. Technician A only
B. Technician B only
C. Both technicians are correct.
D. Neither technician is correct.

WLD-L4
Control Weld Technique
Self-Assessment No. 2 Answer Key

1. a
2. b
3. c
4. c
5. c
6. e
7. d
8. c
9. d
10. d

Name: ______________________________ Date: ___________________________

WLD-L4
Control Weld Technique
Self-Assessment No. 3

Choose the best answer.

1. The size of the bead is __________ proportional to the speed of travel.
    - A. Directly
    - B. Inversely
    - C. Not
    - D. None of the above

2. The eye shield of the welding helmet should be:
    - A. Just light enough to clearly see the arc.
    - B. Too dark to clearly see the arc.
    - C. A minimum of #5.
    - D. None of the above.

3. Welding in confined spaces may require:
    - A. Air supplied hoods or hose masks.
    - B. Frequent breaks.
    - C. Large, high-displacement fans.
    - D. All of the above.
    - E. None of the above.

4. Long sleeves protect the arms against:
    - A. Ultraviolet radiation.
    - B. Infrared radiation.
    - C. Welding splatter.
    - D. All of the above.
    - E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
    - A. Current polarity
    - B. Arc length
    - C. Length of the electrode
    - D. All of the above are variables in the process.
    - E. None of the above.

6. Acceptable welding footwear includes:
   A. Roman sandals.
   B. Tennis shoes.
   C. Canvas boots.
   D. All of the above.
   E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   A. Excess convexity.
   B. Overlap.
   C. Porosity.
   D. All of the above.
   E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   A. DC-.
   B. DC+.
   C. AC.
   D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C: Both Technicians A and B.
   D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
    A. On.
    B. Off.
    C. On or off, depending on the repair.
    D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
    A. On rubber work mats.
    B. Elevated off the floor.
    C. Grounded.
    D. All of the above.
    E. None of the above.

14. Which of the following electrodes is NOT in the low-hydrogen family?
    A. E7015
    B. E7016
    C. E7018
    D. All of the above are low-hydrogen electrodes.
    E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

16. Fire inspections should be continued for at least __________ after completion of the welding.
    A. Fifteen minutes
    B. Thirty minutes
    C. One hour
    D. Two hours

17. The welding area should be:
    A. Isolated from other workers by shields.
    B. At least 35 feet from combustible materials.
    C. Dry.
    D. All of the above.
    E. None of the above.

18. Seam welds generally require _____________ oscillation.
   - A. No
   - B. Very little
   - C. Moderate
   - D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?
   - A. Technician A only.
   - B. Technician B only
   - C. Both Technicians A and B
   - D. Neither Technician A nor B

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:
   - A. Do not weld
   - B. Take frequent breaks to inspect the area for fires
   - C. Station a fire watcher near the combustible materials
   - D. Any of the above is acceptable
   - E. None of the above

21. E7018 electrodes should never be used with
   - A. DC-
   - B. DC+
   - C. AC
   - D. There is no such electrode

22. Areas to be welded should be thoroughly cleaned
   - A. Prior to fit-up
   - B. By brushing, sanding, or grinding
   - C. With safe solvents
   - D. All of the above, as necessary
   - E. None of the above

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?
   - A. Technician A only
   - B. Technician B only
   - C. Both Technicians A and B
   - D. Neither Technician A nor B

24. Low-hydrogen electrodes may be stored
    A. In sealed cans or heated rod ovens
    B. Under water
    C. In petroleum jelly
    D. Any of the above
    E. None of the above

25. As the material being welded increases in thickness, the travel speed of the weld must
    A. Increase
    B. Decrease
    C. Either A or B, depending on the desired effect
    D. Stay the same
    E. None of the above

WLD-L4
Control Weld Technique
Self-Assessment No. 3 Answer Key

1. b
2. a
3. a
4. d
5. c
6. e
7. e
8. c
9. b
10. c
11. c
12. b
13. c
14. d
15. a
16. b
17. d
18. b
19. c
20. c
21. a
22. d
23. b
24. a
25. b

WELDER SERIES

MASTER Technical Module No. WLD-L05

SUBJECT: WELDING TECHNICIAN **TIME:** 12 HOURS

- **DUTY:** SHIELDED METAL ARC WELDING (SMAW) (BASIC)
- **TASK:** Maintain Preheat and Perform Interpass

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Weld carbon steels using the SMAW process;
B. Apply large fillet welds in multiple position on thick material;
C. Perform weave bead techniques for making large welds; and,
D. Understand and practice the methods of destructive testing.

INSTRUCTIONAL MATERIALS:

Student Workbook
Four written tests on welding processes in this module
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video materials
Hobart SMAW wall chart
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Shielded Metal Arc Welding machine
Welding shop tools
Selection of base metals for welding and cutting
Selection of filler metals and electrode wire
MASTER Handout No. 1 (WLD-L5-HO1)
MASTER Handout No. 2 (WLD-L5-HO2)
MASTER Handout No. 3 (WLD-L5-HO3)
MASTER Handout No. 4 (WLD-L5-HO4)
MASTER Handout No. 5 (WLD-L5-HO5)
MASTER Handout No. 6 (WLD-L5-HO6)
MASTER Laboratory Aid (WLD-L5-LA)
MASTER Laboratory Worksheet (WLD-L5-LW)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Reading Welding Blueprints & Symbols, Stinchcomb, Craig, New Jersey: Prentice-Hall, Inc., Latest Edition
Certification Manual For Welding Inspector, American Welding Society, Miami, FL, (ISBN 0-87171-421-3) Latest Edition
Welding Qualifications, Practical Guide to ASME Section IX, Houle, Michael J., *CASTI* Publishing, Inc., Canada, (ISBN 0-9696428-5-7), Latest Edition
The Procedure Handbook of Arc Welding; The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student will complete the following modules:

WLD-L1	"Preheat Joint"
WLD-L2	"Initiate Welding Process"
WLD-L3	"Perform Weld Sequence"
WLD-L4	"Control Weld Technique"

INTRODUCTION:

The Course Introduction will Include:

- An overview of SMAW applications with heavy workpieces
- A class demonstration of multiple pass welding techniques

- A discussion on practical exercises leading to certification in related program areas.

PRESENTATION OUTLINE:

Instructor Topics:

A. Develop skill in repositioning large fillet welds in the horizontal position on thick material
B. Provide practice in multiple pass welding on heavy workpieces
C. Provide an orientation to the requirements of welding codes as they apply to the qualification of welders and procedures
D. Provide practice in weave bead technique for making large welds
E. Define destructive testing and present a brief description of the different methods of destructive testing

Student Activities:

A. Perform multiple pass welding on heavy workpieces; Fillet Weld, Lap Joint, Horizontal Position (21 Bead)
B. Perform welds using 6 bead and $3\text{-}45^0$ weaves: Fillet Weld, Lap Joint, Overhead Position
C. Practice weave bead technique for making large welds, Fillet Weld, Lap Joint, Vertical Position (Uphill)
D. Make adjustments to improve weld quality
E. Perform destructive testing

PRACTICAL APPLICATION:

The student will gain knowledge and experience with practice in making large fillet welds on thick material in multiple positions and performing destructive testing

---

EVALUATION AND/OR VERIFICATION:

Written examinations will be given in this module to determine student progress. Practice on destructive testing is also provided to emphasize the need for weld quality on thick material.

SUMMARY:

This module emphasizes weld quality on thick material and the performance of weld testing. In metals thicker than 1/4 inch, it is frequently necessary to make multipass welds, meaning two or more welds on top of each other in a single joint. The first weld made in such a joint is called the *root pass weld.* Later weld passes are then made to fill the joint. Each pass of a multipass weld must be thoroughly chipped and cleaned to remove slag deposits which prevent food adhesion between welds. Slag removal is also recommended when stopping and restarting a weld. When stopping to insert a new electrode, the end of the weld should be cleaned before restarting the arc.

Usually a steel that requires preheating to a specified temperature also must be kept at this temperature between weld passed. With many weldments, the heat input during welding is adequate to maintain the interpass temperature. On a massive weldment, it is not likely that the heat input of the welding process will be sufficient to maintain required interpass temperature. If this is the case, torch heating between passes may be required. Once an assembly has been preheated and the welding begun, it is desirable to finish the welding as soon as possible so as to avoid the need for interpass heating.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-L6) dealing with using the carbon arc process to cut and gouge base weld materials.

WLD-L5-HO1

Maintain Preheat and Perform Interpass

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Weld carbon steels using the SMAW process;

B. Apply large fillet welds in multiple position on thick material;

C. Perform weave bead techniques for making large welds; and,

D. Understand and practice the methods of destructive testing.

MODULE OUTLINE:

Instructor Topics:

A. Develop skill in repositioning large fillet welds in the horizontal position on thick material

B. Provide practice in multiple pass welding on heavy workpieces

C. Provide an orientation to the requirements of welding codes as they apply to the qualification of welders and procedures

D. Provide practice in weave bead technique for making large welds

E. Define destructive testing and present a brief description of the different methods of destructive testing

Student Activities:

A. Perform multiple pass welding on heavy workpieces; Fillet Weld, Lap Joint, Horizontal Position (21 Bead)

B. Perform welds using 6 bead and 3-45^0 weaves: Fillet Weld, Lap Joint, Overhead Position

C. Practice weave bead technique for making large welds, Fillet Weld, Lap Joint, Vertical Position (Uphill)

D. Make adjustments to improve weld quality

E. Perform destructive testing

WLD-L5-HO2

Maintain Preheat and Perform Interpass

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
    A. Hardening for utility
    B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
    A. Brine (water and sodium chloride or sodium hydroxide)
    B. Water
    C. Fused (liquid) salts
    D. Molten lead
    E. Soluble oil and water
    F. Oil
    G. Air
IV. Estimate Metal Heat Temperature by Color
    A. Use of temper color chart for tempering
    B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes

VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media

VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L5-HO3
Maintain Preheat and Perform Interpass
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
    A. Imprecise method, good for rough estimates only
    B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
    A. High-carbon steels show more spark bursts than do low-carbon steels.
    B. Non-ferrous metals
        1. Aluminum
        2. Magnesium
        3. Brass
        4. Bronze
        5. Nickel
        6. Tin
        7. Others
III. Perform Rockwell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
    A. Ferrous metals
    B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L5-HO4
Maintain Preheat and Perform Interpass
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

   c. Verbally warn others of intent to arc weld
   d. Strike an arc
   e. Weld with stringer bead technique
   f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool

8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height

9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length

10. Cut Steel Plate Using Oxy-Fuel Equipment
   a. Make manual free hand straight line cuts
   b. Cut manually straight lines using cutting jib
   c. Bevel plate with manual oxy-fuel equipment
   d. Manually cut blind holes in thick material
   e. Manually cut sheet metal with minimal distortion

WLD-L5-HO5
Maintain Preheat and Perform Interpass
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

   g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   h. Chip slag and wire brush weld
   i. Grind any lack of fusion and/or high spots
   j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Weld pipe joint
   h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Roll Weld Pipe - SMAW
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Roll weld pipe
   h. Place pipe coupon on workbench in the 1G roll welding position.
   i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L5-HO6
Maintain Preheat and Perform Interpass
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
   - a. Produce end preparations with oxy-fuel cutting
   - b. Produce end preparations with plasma cutting
   - c. Produce end preparations with mechanical cutting
   - d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
   - a. Cut and single bevel pipe to 37 1/2°
   - b. Ground bevel face and touch up to within tolerances
   - c. Check that pipe ends are square within given tolerances
   - d. Prepare root face within given tolerances
   - e. Align pipe to within given tolerances
   - f. Set root opening to within given tolerances
   - g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
   - a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   - b. Weld remainder of pipe in the 1G roll welding position with E6010
   - c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   - a. Weld using 1/8" E6010
   - b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   - c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   - d. Weld root pass to ASME Section 9 requirements
   - e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
   - a. Fit and tack weld pipe to within tolerances
   - b. Place pipe in the 5G position
   - c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
   - d. Grind the finished root pass to remove high spots and any slag at weld toes

    - e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
    - a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
    - b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
    - c. Weld remainder of pipe in 1G position using E7018
    - d. Perform low hydrogen starts and stops
    - e. Weld using stringer bead technique
    - f. Weld using weave technique
    - g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
    - a. Use 1/8" E6010
    - b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
    - c. Fit together two pipe ends to a single V edge preparation within given tolerances
    - c. Weld root pass to ASME Section 9 requirements
    - d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
    - e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
    - a. Set up GMAW equipment
    - b. Adjust wire feeder drive system
    - c. Adjust shielding gas system and flow rate
    - d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
    - e. Set welding condition for short circuit transfer - Wire Feed Speed
    - f. Set welding condition for short circuit transfer - Voltage
    - g. Set welding condition for short circuit transfer - Tip to work Distance
    - h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
    - a. Bevel pipe ends
    - b. Touch up bevel face with grinder
    - c. Fit and tack backing ring to one pipe end
    - d. Fit other pipe over backing ring
    - e. Adjust gap and tack in place
    - f. Adjust shielding gas flow
    - g. Adjust wire feed system
    - h. Adjust power source to procedure specification
    - i. Set wire feed speed to procedure specification
    - j. Adjust voltage to procedure specification
    - k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	Minimum Shade No.	Suggested Shade*
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: **NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.**
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L5-LW
Maintain Preheat and Perform Interpass
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**
   - Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.
   - Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

   Step 1. Choose the proper electrode for the job.

   NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

   The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

   Step 2. Store the electrodes properly.

   a. Low-hydrogen electrodes:

   (1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

   (2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

   (3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

   NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current

DC+(DCRP) Direct Current Reverse Polarity

DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

        - (1) Product design
        - (2) Material thickness
        - (3) Design strength requirements
        - (4) Welding process employed
    - b. SMAW weld joint configuration may be a:
        - (1) Lap joint
        - (2) Tee joint
        - (3) Corner joint
        - (4) Edge joint
        - (5) Butt joint with backing
        - (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
- a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
- b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. **Complete Welding Operation**

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
- a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
- b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
- c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

- a. Type of electrode
- b. Diameter of electrode
- c. Type of current (AC or DC)
- d. Current polarity (DC+ or DC-)
- e. Current setting
- f. Arc length
- g. Travel speed
- h. Electrode angle
- i. Electromagnetic arc blow
- j. Electrode manipulation technique (drag, whip)
- k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

- a. Type of base metal
- b. Thickness of base metal
- c. Surface condition of base metal (clean, rusty, or painted)
- d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

Name ______________________________ Date ____________________________

WLD-L5
Maintain Preheat and Perform Interpass
Self-Assessment No. 1

Circle the best answer.

1. What is the approximate temperature required for stress relief annealing of low-carbon steels?
   - A. 950°
   - B. 1000°
   - C. 1950°
   - D. 1700°
   - E. None of the above

2. What crystalline processes result from stress relief annealing?
   - A. All grains reform into softer grains
   - B. Distorted grains reform into softer grains
   - C. Ferrite grains reform into softer grains while pearlite grains are basically unaffected
   - D. Pearlite grains reform into softer grains while ferrite grains are basically unaffected
   - E. None of the above

3. Which of the following is NOT a cause of quenching cracks?
   - A. Improper quenching medium
   - B. Overheating during the austenitizing cycle
   - C. Improper quenching angle
   - D. All of the above are causes of quenching cracks
   - E. None of the above answers is correct

4. Which of the following is NOT a characteristic of typical quench cracks?
   - A. The fracture tends to run from the surface toward the center in a smooth curve
   - B. Untempered quench cracks will not show any decarburization
   - C. Tempered fracture surfaces will show a fine crystalline structure
   - D. All of the above are characteristic of quench cracks
   - E. None of the above

5. During tempering by color, which of the following colors represents the highest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

6. During tempering by color, which of the following colors represents the lowest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

7. What is meant by *step quenching*?
   - A. The workpiece is first quenched in a slow medium (e.g., air) then in a fast medium (e.g., water)
   - B. The workpiece is first quenched in a fast medium (e.g., water) then in a slow medium (e.g., air)
   - C. The weaker parts of the workpiece are quenched separately from the main body of the workpiece
   - D. The workpiece is lowered into the quenching medium in steps so that different parts of the workpiece attain different hardnesses
   - E. None of the above

8. What is the simplest thing that the technician can do to minimize the vapor-blanket stage of liquid quenching?
   - A. Agitate the workpiece or the medium
   - B. Heat the quenching medium to just below its boiling point
   - C. Quickly insert the workpiece into the medium
   - D. Slowly insert the workpiece into the medium
   - E. None of the above

9. Liquid carburizing, as used in case hardening, utilizes __________ and is therefore extremely dangerous.
   - A. Sodium chloride
   - B. Calcium carbonate
   - C. Cyanide salts
   - D. Ammonia
   - E. None of the above

10. Workpieces which have been cut with an oxyacetylene torch often display edge hardness because

A. The torch was starved for oxygen
B. The workpiece was cut at too low a temperature
C. The wrong type of cutting torch was used
D. Oxyacetylene torches always leave hardened edges
E. None of the above

WLD-L5
Maintain Preheat and Perform Interpass
Self-Assessment No. 1 Answer Key

1. a
2. c
3. d
4. a
5. c
6. d
7. b
8. a
9. c
10. a

Name ______________________________ Date ____________________

WLD-L5
Maintain Preheat and Perform Interpass
Self-Assessment No. 2

Circle the best answer.

1. The *hardness* of a metal is its ability to resist:
   - A. Permanent deformation.
   - B. Oxidation.
   - C. Chemical reaction.
   - D. All of the above answers are forms of hardness.
   - E. None of the above.

2. Rockwell testing machines test the sample metal's resistance to:
   - A. Abrasion.
   - B. Penetration.
   - C. Elastic deformation.
   - D. Electricity.
   - E. None of the above.

3. Materials such as nitrided steel and hard cast irons generally have Rockwell hardness numbers in excess of
   - A. B-50.
   - B. B-75.
   - C. B- 100.
   - D. B-150.
   - E. None of the above.

4. During the file test, if the file will mark the metal but not cut into it, then the metal should be treated as:
   - A. High-alloy steel.
   - B. Mild steel.
   - C. Hardened tool steel.
   - D. Medium-carbon steel.
   - E. None of the above.

5. Probably the best use of the spark test is to:
   - A. Determine the alloy content of the sample.
   - B. Identify cast iron.
   - C. Compare the sample to a known piece.
   - D. All of the above answers are valid.
   - E. None of the above.

6. Tool steel has a Rockwell hardness of __________, while hardened tool steel has hardness number of __________.
   - A. C-42 - C-64
   - B. C-42 - B-65
   - C. C-64 - C-42
   - D. B-65 - C-42
   - E. None of the above.

7. Which of the following surfaces should be avoided when hardness testing?
   - A. Curved
   - B. Rough
   - C. Decarburized
   - D. All of the above surfaces should be modified before testing the sample's hardness.
   - E. None of the above.

8. For hardness testing, the minimum recommended clearance from the edge is:
   - A. 1/2"
   - B. 1/4"
   - C. 1/8"
   - D. 1/16"
   - E. None of the above.

9. If a Rockwell tester is in daily use, it should be calibrated:
   - A. Annually.
   - B. Monthly.
   - C. Weekly.
   - D. Daily.
   - E. Never.

10. Technician A says that, for large samples, multiple hardness test should be made and their results averaged. Technician B says that many materials vary in hardness over the length of the sample. Who is correct?
    - A. Technician A only
    - B. Technician B only
    - C. Both technicians are correct.
    - D. Neither technician is correct.

WLD-L5
Maintain Preheat and Perform Interpass
Self-Assessment No. 2 Answer Key

1.	a
2.	b
3.	c
4.	c
5.	c
6.	e
7.	d
8.	c
9.	d
10.	d

Name: ______________________________ Date: ___________________________

WLD-L5
Maintain Preheat and Perform Interpass
Self-Assessment No. 3

Choose the best answer.

1. The size of the bead is __________ proportional to the speed of travel.
   - A. Directly
   - B. Inversely
   - C. Not
   - D. None of the above

2. The eye shield of the welding helmet should be:
   - A. Just light enough to clearly see the arc.
   - B. Too dark to clearly see the arc.
   - C. A minimum of #5.
   - D. None of the above.

3. Welding in confined spaces may require:
   - A. Air supplied hoods or hose masks.
   - B. Frequent breaks.
   - C. Large, high-displacement fans.
   - D. All of the above.
   - E. None of the above.

4. Long sleeves protect the arms against:
   - A. Ultraviolet radiation.
   - B. Infrared radiation.
   - C. Welding splatter.
   - D. All of the above.
   - E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
   - A. Current polarity
   - B. Arc length
   - C. Length of the electrode
   - D. All of the above are variables in the process.
   - E. None of the above.

6. Acceptable welding footwear includes:
   - A. Roman sandals.
   - B. Tennis shoes.
   - C. Canvas boots.
   - D. All of the above.
   - E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   - A. Excess convexity.
   - B. Overlap.
   - C. Porosity.
   - D. All of the above.
   - E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   - A. Technician A only.
   - B. Technician B only.
   - C. Both Technicians A and B.
   - D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   - A. DC-.
   - B. DC+.
   - C. AC.
   - D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
    - A. Technician A only.
    - B. Technician B only.
    - C. Both Technicians A and B.
    - D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
    - A. Technician A only.
    - B. Technician B only.
    - C. Both Technicians A and B.
    - D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
    A. On.
    B. Off.
    C. On or off, depending on the repair.
    D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
    A. On rubber work mats.
    B. Elevated off the floor.
    C. Grounded.
    D. All of the above.
    E. None of the above.

14. Which of the following electrodes is NOT in the low-hydrogen family?
    A. E7015
    B. E7016
    C. E7018
    D. All of the above are low-hydrogen electrodes.
    E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

16. Fire inspections should be continued for at least __________ after completion of the welding.
    A. Fifteen minutes
    B. Thirty minutes
    C. One hour
    D. Two hours

17. The welding area should be:
    A. Isolated from other workers by shields.
    B. At least 35 feet from combustible materials.
    C. Dry.
    D. All of the above.
    E. None of the above.

18. Seam welds generally require _____________ oscillation.
A. No
B. Very little
C. Moderate
D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?
A. Technician A only.
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:
A. Do not weld
B. Take frequent breaks to inspect the area for fires
C. Station a fire watcher near the combustible materials
D. Any of the above is acceptable
E. None of the above

21 E7018 electrodes should never be used with
A. DC-
B. DC+
C. AC
D. There is no such electrode

22. Areas to be welded should be thoroughly cleaned
A. Prior to fit-up
B. By brushing, sanding, or grinding
C. With safe solvents
D. All of the above, as necessary
E. None of the above

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?
A. Technician A only
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

24. Low-hydrogen electrodes may be stored
    A. In sealed cans or heated rod ovens
    B. Under water
    C. In petroleum jelly
    D. Any of the above
    E. None of the above

25. As the material being welded increases in thickness, the travel speed of the weld must
    A. Increase
    B. Decrease
    C. Either A or B, depending on the desired effect
    D. Stay the same
    E. None of the above

WLD-L5

Maintain Preheat and Perform Interpass

Self-Assessment No. 3 Answer Key

1. b
2. a
3. a
4. d
5. c
6. e
7. e
8. c
9. b
10. c
11. c
12. b
13. c
14. d
15. a
16. b
17. d
18. b
19. c
20. c
21. a
22. d
23. b
24. a
25. b

WLD-L6

WELDER SERIES
MASTER Technical Module No. WLD-L06

SUBJECT: **WELDING TECHNICIAN** **TIME: 8 HOURS**

- **DUTY:** **SHIELDED METAL ARC WELDING (SMAW) (BASIC)**
- **TASK:** Use the Carbon Arc Process to Cut and Gouge Base Weld Materials

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Cut cast iron with air carbon arc process;
B. Cut carbon steels using shielded metal arc cutting process; and,
C. Gouge carbon steels with air carbon arc process.

INSTRUCTIONAL MATERIALS:

Student Workbook
Two written exams on air carbon arc cutting processes
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video materials
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Shielded Metal Arc Welding machine
Welding shop tools
Selection of base metals for welding and cutting
Selection of filler metals and electrode wire
MASTER Handout No. 1 (WLD-L6-HO1)
MASTER Handout No. 2 (WLD-L6-HO2)
MASTER Handout No. 3 (WLD-L6-HO3)
MASTER Handout No. 4 (WLD-L6-HO4)
MASTER Handout No. 5 (WLD-L6-HO5)
MASTER Handout No. 6 (WLD-L6-HO6)
MASTER Laboratory Aid (WLD-L6-LA)
MASTER Laboratory Worksheet (WLD-L6-LW)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Reading Welding Blueprints & Symbols, Stinchcomb, Craig, New Jersey: Prentice-Hall, Inc., Latest Edition
Certification Manual For Welding Inspector, American Welding Society, Miami, FL, (ISBN 0-87171-421-3) Latest Edition
Welding Qualifications, Practical Guide to ASME Section IX, Houle, Michael J., *CASTI* Publishing, Inc., Canada, (ISBN 0-9696428-5-7), Latest Edition
The Procedure Handbook of Arc Welding; The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students should complete the following modules:

WLD-L1	"Preheat Joint"
WLD-L2	"Initiate Welding Process"
WLD-L3	"Perform Weld Sequence"
WLD-L4	"Control Weld Technique"
WLD-L5	"Maintain Preheat and Perform Interpass"

INTRODUCTION:

The Course Introduction will Include:

- An overview of air carbon arc techniques for cutting and gouging
- A discussion of training activities resulting in an increase of skill and knowledge in related program areas.

PRESENTATION OUTLINE:

Instructor Topics:

A. Cutting cast iron, etc. with air carbon arc process
B. Cutting carbon steels using air carbon arc process
C. Gouging carbon steels with air carbon process
D. Perform interpass preparation

Student Activities:

A. Understand cutting processes for cast iron, and carbon steels
B. Use air carbon arc in cutting and gouging
C. Perform multiple cutting operations
D. Select materials for optimum performance
E. Adjust equipment for performance and quality
F. Practice interpass preparation

PRACTICAL APPLICATION:

The student will gain knowledge and experience with cutting and gouging methods for air carbon arc welding. All work will be supervised by instructor and followed by a critique of methods, techniques and outcomes.

EVALUATION AND/OR VERIFICATION:

Written examinations will be given in this module to determine student progress. Practical exercises will be supervised and evaluated by instructor.

SUMMARY:

Cutting methods must be mastered by the multi-skilled welder who wishes to be considered as a professional. Air carbon arc cutting (CAC-A) is a physical means of removing base metal or weld metal by using a carbon electrode, an electric arc and compressed air. In the air carbon arc process the intense heat of the arc between the carbon electrode and the workpiece melts a portion of the base metal, or weld. Simultaneously a jet of air is passed through the arc, of sufficient volume and velocity to blow away the molten material. This sequence can be repeated until the required groove or cut has been obtained.

Since the CAC-A process does not depend on oxidation to maintain the cut, it is capable of cutting stainless steel, many copper alloys and cast iron. Material can be removed approximately five times faster by arc gouging than by chipping. The cost of operating gouging equipment is generally less than for chipping hammers or gas-cutting torches, and the arc-gouging equipment also requires less space. An arc-gouged surface is clean and smooth and can usually be welded without further preparation. The process has several drawbacks, however. It is not as good as other processes for through-cutting, and large volumes of compressed air are required. Increased hardness produced on cast iron and air-hardenable materials may be objectionable.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-L7) dealing with applying welders identification.

WLD-L6-HO1
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Cut cast iron with air carbon arc process;
B. Cut carbon steels using shielded metal arc cutting process; and,
C. Gouge carbon steels with air carbon arc process.

MODULE OUTLINE:

Instructor Topics:

A. Cutting cast iron, etc. with air carbon arc process
B. Cutting carbon steels using air carbon arc process
C. Gouging carbon steels with air carbon process
D. Perform interpass preparation

Student Activities:

A. Understand cutting processes for cast iron, and carbon steels
B. Use air carbon arc in cutting and gouging
C. Perform multiple cutting operations
D. Select materials for optimum performance
E. Adjust equipment for performance and quality
F. Practice interpass preparation

WLD-L6-HO2
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- a. Discuss the reasons for heat treating;
- b. Discuss the time/temperature chart
- c. List the different quenching media
- d. Estimate metal heat temperature by color; and
- e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

- I. Discuss the Reasons for Heat Treating
  - A. Hardening for utility
  - B. Tempering for toughness without brittleness
- II. Discuss the Time/Temperature Chart
- III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  - A. Brine (water and sodium chloride or sodium hydroxide)
  - B. Water
  - C. Fused (liquid) salts
  - D. Molten lead
  - E. Soluble oil and water
  - F. Oil
  - G. Air
- IV. Estimate Metal Heat Temperature by Color
  - A. Use of temper color chart for tempering
  - B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L6-HO3

Use the Carbon Arc Process to Cut and Gouge Base Weld Materials

Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
    A. Imprecise method, good for rough estimates only
    B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
    A. High-carbon steels show more spark bursts than do low-carbon steels.
    B. Non-ferrous metals
        1. Aluminum
        2. Magnesium
        3. Brass
        4. Bronze
        5. Nickel
        6. Tin
        7. Others
III. Perform Rockwell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
    A. Ferrous metals
    B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L6-HO4
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

- c. Verbally warn others of intent to arc weld
- d. Strike an arc
- e. Weld with stringer bead technique
- f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
    - a. Maintain required weld quality
    - b. Maintain proper weld width uniformly
    - c. Maintain proper travel speed
    - d. Match correct oscillation for various electrodes
    - e. Match applications to weave techniques, as they apply
    - f. List the advantages and disadvantages of weave techniques
    - g. List the advantages and disadvantages of stringer techniques
    - h. Perform weld using weave technique
    - i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
    - a. Weld a dam to outline area being welded for each layer
    - b. Apply each layer neatly, straight and with good fusion throughout
    - c. Chip slag after each pass
    - d. Weld passes which over lap to crown of last weld bead
    - e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
    - a. Follow manufacturer's recommended practice
    - b. Inspect equipment and work area for safety
    - c. Assemble oxy-fuel equipment
    - d. Open fuel gas cylinder ½ turn
    - e. Open oxygen as cylinder all the way
    - f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
    - g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    - a. Make manual free hand straight line cuts
    - b. Cut manually straight lines using cutting jib
    - c. Bevel plate with manual oxy-fuel equipment
    - d. Manually cut blind holes in thick material
    - e. Manually cut sheet metal with minimal distortion

WLD-L6-HO5

Use the Carbon Arc Process to Cut and Gouge Base Weld Materials

Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
h. Chip slag and wire brush weld
i. Grind any lack of fusion and/or high spots
j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
k. Visually inspect weld on the root and face sides to ASME Section 9
l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Weld pipe joint
   h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Roll weld pipe
   h. Place pipe coupon on workbench in the 1G roll welding position.
   i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

- k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
- l. Visually inspect weld on the root and face sides to ASME Section 9
- m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   - a. Measure the pipe and
   - b. Mark the cut line with a wrap around and soapstone
   - c. Cut the bevel using oxy-fuel gas equipment
   - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Weld pipe
   - g. Tack the single V groove pipe joint with a 3/32" root opening
   - h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   - i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   - j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   - k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   - l. Visually inspect weld on the root and face sides to ASME Section 9
   - m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
7. Produce SMAW Pipe - 6G Position
   - a. Measure the pipe
   - b. Mark the cut line with a wrap around and soapstone
   - c. Cut the bevel using oxy-fuel gas equipment
   - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Tack the single V groove pipe joint with a 3/32" root opening
   - g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   - h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   - i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   - j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   - k. Visually inspect weld on the root and face sides to ASME Section 9

- l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    - a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    - b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    - c. Set welding condition to weld open roots
    - d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    - e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    - f. Weld balance of the V groove with this procedure
    - g. Visual inspection is made and evaluated by ASME Section 9
    - h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    - a. Identify process
    - b. Name joint design
    - c. List base material
    - d. Give dimensions for root treatment
    - e. Name electrode size and type being used
    - f. List filler material (if required), classification and specification
    - g. Identify shielding gas - type and mixture
    - h. List pre and post heat and interpass temperature
    - i. Describe initial and interpass cleaning
    - j. Describe technique which is used
    - k. Produce single or multiple pass weld
    - l. Choose current type
    - m. Set current amperage
    - n. Set current polarity
    - o. Set voltage

WLD-L6-HO6
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    - a. Produce end preparations with oxy-fuel cutting
    - b. Produce end preparations with plasma cutting
    - c. Produce end preparations with mechanical cutting
    - d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    - a. Cut and single bevel pipe to 37 1/2°
    - b. Ground bevel face and touch up to within tolerances
    - c. Check that pipe ends are square within given tolerances
    - d. Prepare root face within given tolerances
    - e. Align pipe to within given tolerances
    - f. Set root opening to within given tolerances
    - g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    - a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    - b. Weld remainder of pipe in the 1G roll welding position with E6010
    - c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    - a. Weld using 1/8" E6010
    - b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    - c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    - d. Weld root pass to ASME Section 9 requirements
    - e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    - a. Fit and tack weld pipe to within tolerances
    - b. Place pipe in the 5G position
    - c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
    - d. Grind the finished root pass to remove high spots and any slag at weld toes

e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   c. Weld remainder of pipe in 1G position using E7018
   d. Perform low hydrogen starts and stops
   e. Weld using stringer bead technique
   f. Weld using weave technique
   g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   a. Use 1/8" E6010
   b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   c. Fit together two pipe ends to a single V edge preparation within given tolerances
   c. Weld root pass to ASME Section 9 requirements
   d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
   a Set up GMAW equipment
   b Adjust wire feeder drive system
   c Adjust shielding gas system and flow rate
   d Adjust GMAW gun to allow proper tip to work distance and gas coverage
   e Set welding condition for short circuit transfer - Wire Feed Speed
   f Set welding condition for short circuit transfer - Voltage
   g Set welding condition for short circuit transfer - Tip to work Distance
   h Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
   a Bevel pipe ends
   b Touch up bevel face with grinder
   c Fit and tack backing ring to one pipe end
   d Fit other pipe over backing ring
   e Adjust gap and tack in place
   f Adjust shielding gas flow
   g Adjust wire feed system
   h Adjust power source to procedure specification
   i. Set wire feed speed to procedure specification
   j. Adjust voltage to procedure specification
   k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L6-LA

Use the Carbon Arc Process to Cut and Gouge Base Weld Materials

Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC	Alternating Current
DC+(DCRP)	Direct Current Reverse Polarity
DC-(DCSP)	Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. **Prepare Weldment for Welding**

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

- (1) Product design
- (2) Material thickness
- (3) Design strength requirements
- (4) Welding process employed

b. SMAW weld joint configuration may be a:

- (1) Lap joint
- (2) Tee joint
- (3) Corner joint
- (4) Edge joint
- (5) Butt joint with backing
- (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up

- a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
- b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.

- a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
- b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
- c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

- a. As the material thickness increases, the travel speed must slow down.
- b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
- c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

- a. Type of electrode
- b. Diameter of electrode
- c. Type of current (AC or DC)
- d. Current polarity (DC+ or DC-)
- e. Current setting
- f. Arc length
- g. Travel speed
- h. Electrode angle
- i. Electromagnetic arc blow
- j. Electrode manipulation technique (drag, whip)
- k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

- a. Type of base metal
- b. Thickness of base metal
- c. Surface condition of base metal (clean, rusty, or painted)
- d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

Name ______________________________ Date ______________________________

WLD-L6
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Self-Assessment No. 1

Circle the best answer.

1. What is the approximate temperature required for stress relief annealing of low-carbon steels?
   - A. 950°
   - B. 1000°
   - C. 1950°
   - D. 1700°
   - E. None of the above

2. What crystalline processes result from stress relief annealing?
   - A. All grains reform into softer grains
   - B. Distorted grains reform into softer grains
   - C. Ferrite grains reform into softer grains while pearlite grains are basically unaffected
   - D. Pearlite grains reform into softer grains while ferrite grains are basically unaffected
   - E. None of the above

3. Which of the following is NOT a cause of quenching cracks?
   - A. Improper quenching medium
   - B. Overheating during the austenitizing cycle
   - C. Improper quenching angle
   - D. All of the above are causes of quenching cracks
   - E. None of the above answers is correct

4. Which of the following is NOT a characteristic of typical quench cracks?
   - A. The fracture tends to run from the surface toward the center in a smooth curve
   - B. Untempered quench cracks will not show any decarburization
   - C. Tempered fracture surfaces will show a fine crystalline structure
   - D. All of the above are characteristic of quench cracks
   - E. None of the above

5. During tempering by color, which of the following colors represents the highest temperature?
   A. Gold
   B. Purple
   C. Dark Straw
   D. Pale Blue
   E. Violet

6. During tempering by color, which of the following colors represents the lowest temperature?
   A. Gold
   B. Purple
   C. Dark Straw
   D. Pale Blue
   E. Violet

7. What is meant by *step quenching*?
   A. The workpiece is first quenched in a slow medium (e.g., air) then in a fast medium (e.g., water)
   B. The workpiece is first quenched in a fast medium (e.g., water) then in a slow medium (e.g., air)
   C. The weaker parts of the workpiece are quenched separately from the main body of the workpiece
   D. The workpiece is lowered into the quenching medium in steps so that different parts of the workpiece attain different hardnesses
   E. None of the above

8. What is the simplest thing that the technician can do to minimize the vapor-blanket stage of liquid quenching?
   A. Agitate the workpiece or the medium
   B. Heat the quenching medium to just below its boiling point
   C. Quickly insert the workpiece into the medium
   D. Slowly insert the workpiece into the medium
   E. None of the above

9. Liquid carburizing, as used in case hardening, utilizes __________ and is therefore extremely dangerous.
   A. Sodium chloride
   B. Calcium carbonate
   C. Cyanide salts
   D. Ammonia
   E. None of the above

10. Workpieces which have been cut with an oxyacetylene torch often display edge hardness because

A. The torch was starved for oxygen
B. The workpiece was cut at too low a temperature
C. The wrong type of cutting torch was used
D. Oxyacetylene torches always leave hardened edges
E. None of the above

WLD-L6
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Self-Assessment No. 1 Answer Key

1. a

2. c

3. d

4. a

5. c

6. d

7. b

8. a

9. c

10. a

Name ______________________________ Date ____________________

WLD-L6

Use the Carbon Arc Process to Cut and Gouge Base Weld Materials

Self-Assessment No. 2

Circle the best answer.

1. The *hardness* of a metal is its ability to resist:
   A. Permanent deformation.
   B. Oxidation.
   C. Chemical reaction.
   D. All of the above answers are forms of hardness.
   E. None of the above.

2. Rockwell testing machines test the sample metal's resistance to:
   A. Abrasion.
   B. Penetration.
   C. Elastic deformation.
   D. Electricity.
   E. None of the above.

3. Materials such as nitrided steel and hard cast irons generally have Rockwell hardness numbers in excess of
   A. B-50.
   B. B-75.
   C. B- 100.
   D. B-150.
   E. None of the above.

4. During the file test, if the file will mark the metal but not cut into it, then the metal should be treated as:
   A. High-alloy steel.
   B. Mild steel.
   C. Hardened tool steel.
   D. Medium-carbon steel.
   E. None of the above.

5. Probably the best use of the spark test is to:
   A. Determine the alloy content of the sample.
   B. Identify cast iron.
   C. Compare the sample to a known piece.
   D. All of the above answers are valid.
   E. None of the above.

6. Tool steel has a Rockwell hardness of __________, while hardened tool steel has hardness number of __________.
   A. C-42 - C-64
   B. C-42 - B-65
   C. C-64 - C-42
   D. B-65 - C-42
   E. None of the above.

7. Which of the following surfaces should be avoided when hardness testing?
   A. Curved
   B. Rough
   C. Decarburized
   D. All of the above surfaces should be modified before testing the sample's hardness.
   E. None of the above.

8. For hardness testing, the minimum recommended clearance from the edge is:
   A. 1/2"
   B. 1/4"
   C. 1/8"
   D. 1/16"
   E. None of the above.

9. If a Rockwell tester is in daily use, it should be calibrated:
   A. Annually.
   B. Monthly.
   C. Weekly.
   D. Daily.
   E. Never.

10. Technician A says that, for large samples, multiple hardness test should be made and their results averaged. Technician B says that many materials vary in hardness over the length of the sample. Who is correct?
   A. Technician A only
   B. Technician B only
   C. Both technicians are correct.
   D. Neither technician is correct.

WLD-L6
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Self-Assessment No. 2 Answer Key

1. a

2. b

3. c

4. c

5. c

6. e

7. d

8. c

9. d

10. d

Name: ______________________________ Date: ___________________________

WLD-L6
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Self-Assessment No. 3

Choose the best answer.

1. The size of the bead is __________ proportional to the speed of travel.
    A. Directly
    B. Inversely
    C. Not
    D. None of the above

2. The eye shield of the welding helmet should be:
    A. Just light enough to clearly see the arc.
    B. Too dark to clearly see the arc.
    C. A minimum of #5.
    D. None of the above.

3. Welding in confined spaces may require:
    A. Air supplied hoods or hose masks.
    B. Frequent breaks.
    C. Large, high-displacement fans.
    D. All of the above.
    E. None of the above.

4. Long sleeves protect the arms against:
    A. Ultraviolet radiation.
    B. Infrared radiation.
    C. Welding splatter.
    D. All of the above.
    E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
    A. Current polarity
    B. Arc length
    C. Length of the electrode
    D. All of the above are variables in the process.
    E. None of the above.

6. Acceptable welding footwear includes:
   - A. Roman sandals.
   - B. Tennis shoes.
   - C. Canvas boots.
   - D. All of the above.
   - E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   - A. Excess convexity.
   - B. Overlap.
   - C. Porosity.
   - D. All of the above.
   - E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   - A. Technician A only.
   - B. Technician B only.
   - C. Both Technicians A and B.
   - D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   - A. DC-.
   - B. DC+.
   - C. AC.
   - D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
    - A. Technician A only.
    - B. Technician B only.
    - C. Both Technicians A and B.
    - D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
    - A. Technician A only.
    - B. Technician B only.
    - C. Both Technicians A and B.
    - D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
    A. On.
    B. Off.
    C. On or off, depending on the repair.
    D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
    A. On rubber work mats.
    B. Elevated off the floor.
    C. Grounded.
    D. All of the above.
    E. None of the above.

14. Which of the following electrodes is NOT in the low-hydrogen family?
    A. E7015
    B. E7016
    C. E7018
    D. All of the above are low-hydrogen electrodes.
    E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

16. Fire inspections should be continued for at least __________ after completion of the welding.
    A. Fifteen minutes
    B. Thirty minutes
    C. One hour
    D. Two hours

17. The welding area should be:
    A. Isolated from other workers by shields.
    B. At least 35 feet from combustible materials.
    C. Dry.
    D. All of the above.
    E. None of the above.

18. Seam welds generally require _____________ oscillation.
   A. No
   B. Very little
   C. Moderate
   D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?
   A. Technician A only.
   B. Technician B only
   C. Both Technicians A and B
   D. Neither Technician A nor B

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:
   A. Do not weld
   B. Take frequent breaks to inspect the area for fires
   C. Station a fire watcher near the combustible materials
   D. Any of the above is acceptable
   E. None of the above

21. E7018 electrodes should never be used with
   A. DC-
   B. DC+
   C. AC
   D. There is no such electrode

22. Areas to be welded should be thoroughly cleaned
   A. Prior to fit-up
   B. By brushing, sanding, or grinding
   C. With safe solvents
   D. All of the above, as necessary
   E. None of the above

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?
   A. Technician A only
   B. Technician B only
   C. Both Technicians A and B
   D. Neither Technician A nor B

24. Low-hydrogen electrodes may be stored
   A. In sealed cans or heated rod ovens
   B. Under water
   C. In petroleum jelly
   D. Any of the above
   E. None of the above

25. As the material being welded increases in thickness, the travel speed of the weld must
   A. Increase
   B. Decrease
   C. Either A or B, depending on the desired effect
   D. Stay the same
   E. None of the above

WLD-L6

Use the Carbon Arc Process to Cut and Gouge Base Weld Materials

Self-Assessment No. 3 Answer Key

1.	b
2.	a
3.	a
4.	d
5.	c
6.	e
7.	e
8.	c
9.	b
10.	c
11.	c
12.	b
13.	c
14.	d
15.	a
16.	b
17.	d
18.	b
19.	c
20.	c
21.	a
22.	d
23.	b
24.	a
25.	b

WELDER SERIES

MASTER Technical Module No. WLD-L07

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **SHIELDED METAL ARC WELDING (SMAW) (BASIC)**
- **TASK:** Apply Welders Identification

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Discuss welder identification systems;
B. Use tools, etc., to apply welder identification; and,
C. Use temperature sticks to indicate temperatures.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on processes in this module
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video materials
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Shielded Metal Arc Welding machine
Welding shop tools
Selection of base metals for welding and cutting
Selection of filler metals and electrode wire
MASTER Handout No. 1 (WLD-L7-HO1)
MASTER Handout No. 2 (WLD-L7-HO2)
MASTER Handout No. 3 (WLD-L7-HO3)
MASTER Handout No. 4 (WLD-L7-HO4)
MASTER Handout No. 5 (WLD-L7-HO5)
MASTER Handout No. 6 (WLD-L7-HO6)
MASTER Laboratory Aid (WLD-L7-LA)
MASTER Laboratory Worksheet (WLD-L7-LW)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Reading Welding Blueprints & Symbols, Stinchcomb, Craig, New Jersey: Prentice-Hall, Inc., Latest Edition
Certification Manual For Welding Inspector, American Welding Society, Miami, FL, (ISBN 0-87171-421-3) Latest Edition
Welding Qualifications, Practical Guide to ASME Section IX, Houle, Michael J., *CASTI* Publishing, Inc., Canada, (ISBN 0-9696428-5-7), Latest Edition
The Procedure Handbook of Arc Welding; The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students will complete the following modules:

WLD-L1	"Preheat Joint"
WLD-L2	"Initiate Welding Process"
WLD-L3	"Perform Weld Sequence"
WLD-L4	"Control Weld Technique"
WLD-L5	"Maintain Preheat and Perform Interpass"
WLD-L6	"Use the Carbon Arc Process to Cut and Gouge Base Weld Materials"

INTRODUCTION:

The Course Introduction will Include:

- An overview of practices and expectations of the welding profession
- A class demonstration of marking of work by applying welder identification

PRESENTATION OUTLINE:

Instructor Topics:

A. Welder's Identification applied using AWS guidelines and welding procedure specification
B. Welders Tools used for marking
C. Marking and Identification of materials by Welding Inspectors
D. Methods to Indicate Temperatures

Student Activities:

Students will observe examples of company procedures for marking:

A. Any required individual identification marked will be adjacent to each weld
B. Companies provide instructions in welding operations manual or manufacturing instructions and procedures
C. Markings are usually made with low stress steel die stamps
D. Requirements for detailed records are included in welding procedure specification
E. Students will practice with temperature "sticks" or indicators that melt or change color

PRACTICAL APPLICATION:

The student will gain knowledge and experience with practice in Welder's Identification and marking materials using AWS guidelines.

EVALUATION AND/OR VERIFICATION:

Written examinations will be given in this module to determine student progress. Students will use welders identification tools and temperature indicators.

SUMMARY:

Marking of work is guided by welding procedures, policies, or specifications and is an important indicator of quality procedures being followed.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-L8) dealing with controlling post-weld temperature according to procedures.

WLD-L7-HO1
Apply Welders Identification
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Discuss welder identification systems;

B. Use tools, etc., to apply welder identification; and,

C. Use temperature sticks to indicate temperatures.

MODULE OUTLINE:

Instructor Topics:

A. Welder's Identification applied using AWS guidelines and welding procedure specification

B. Welders Tools used for marking

C. Marking and Identification of materials by Welding Inspectors

D. Methods to Indicate Temperatures

Student Activities:

Students will observe examples of company procedures for marking:

A. Any required individual identification marked will be adjacent to each weld

B. Companies provide instructions in welding operations manual or manufacturing instructions and procedures

C. Markings are usually made with low stress steel die stamps

D. Requirements for detailed records are included in welding procedure specification

E. Students will practice with temperature "sticks" or indicators that melt or change color

WLD-L7-HO2
Apply Welders Identification
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Discuss the reasons for heat treating;
- b. Discuss the time/temperature chart
- c. List the different quenching media
- d. Estimate metal heat temperature by color; and
- e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

- I. Discuss the Reasons for Heat Treating
  - A. Hardening for utility
  - B. Tempering for toughness without brittleness
- II. Discuss the Time/Temperature Chart
- III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  - A. Brine (water and sodium chloride or sodium hydroxide)
  - B. Water
  - C. Fused (liquid) salts
  - D. Molten lead
  - E. Soluble oil and water
  - F. Oil
  - G. Air
- IV. Estimate Metal Heat Temperature by Color
  - A. Use of temper color chart for tempering
  - B. *Chicken Wire* markings warn of overheating

Temperature (F)	**Temperature (C)**	**Oxide Color**	**Suggested Uses**
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L7-HO3
Apply Welders Identification
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
  A. Imprecise method, good for rough estimates only
  B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
  A. High-carbon steels show more spark bursts than do low-carbon steels.
  B. Non-ferrous metals
    1. Aluminum
    2. Magnesium
    3. Brass
    4. Bronze
    5. Nickel
    6. Tin
    7. Others
III. Perform Rockwell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
  A. Ferrous metals
  B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L7-HO4
Apply Welders Identification
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    - a. Define arc welding process terms
    - b. Define standard joint terminology
    - c. Define common weld discontinuities
    - d. Name welding equipment, supply and consumables
    - e. Define common shop terms including proper equipment names
    - f. Define material terms
    - g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    - a. List, describe and define
    - b. List low hydrogen electrodes
    - c. List iron powder electrodes
    - d. Describe electrode by welding position
    - e. Describe electrode by current and polarity
    - f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    - a. List polarities for commonly used electrodes
    - b. Describe both polarities
    - c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    - a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    - b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    - c. List reasons for the importance of low hydrogen in weld metal
    - d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    - a. Inspect area for safety
    - b. Adjust current and polarity for specific job requirements
    - c. Choose type and size of electrode
    - d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    - a. Stand and position oneself correctly
    - b. Operate welding helmet

c. Verbally warn others of intent to arc weld
d. Strike an arc
e. Weld with stringer bead technique
f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
   a. Make manual free hand straight line cuts
   b. Cut manually straight lines using cutting jib
   c. Bevel plate with manual oxy-fuel equipment
   d. Manually cut blind holes in thick material
   e. Manually cut sheet metal with minimal distortion

WLD-L7-HO5
Apply Welders Identification
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

    g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    h. Chip slag and wire brush weld
    i. Grind any lack of fusion and/or high spots
    j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Weld pipe joint
    h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Roll Weld Pipe - SMAW
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Roll weld pipe
    h. Place pipe coupon on workbench in the 1G roll welding position.
    i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

- k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
- l. Visually inspect weld on the root and face sides to ASME Section 9
- m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
    - a. Measure the pipe and
    - b. Mark the cut line with a wrap around and soapstone
    - c. Cut the bevel using oxy-fuel gas equipment
    - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    - e. Use the grinder to add a root face of from 3/32" to 1/8"
    - f. Weld pipe
    - g. Tack the single V groove pipe joint with a 3/32" root opening
    - h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
    - i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    - j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    - k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    - l. Visually inspect weld on the root and face sides to ASME Section 9
    - m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
7. Produce SMAW Pipe - 6G Position
    - a. Measure the pipe
    - b. Mark the cut line with a wrap around and soapstone
    - c. Cut the bevel using oxy-fuel gas equipment
    - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    - e. Use the grinder to add a root face of from 3/32" to 1/8"
    - f. Tack the single V groove pipe joint with a 3/32" root opening
    - g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
    - h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    - i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    - j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    - k. Visually inspect weld on the root and face sides to ASME Section 9

- l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    - a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    - b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    - c. Set welding condition to weld open roots
    - d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    - e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    - f. Weld balance of the V groove with this procedure
    - g. Visual inspection is made and evaluated by ASME Section 9
    - h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    - a. Identify process
    - b. Name joint design
    - c. List base material
    - d. Give dimensions for root treatment
    - e. Name electrode size and type being used
    - f. List filler material (if required), classification and specification
    - g. Identify shielding gas - type and mixture
    - h. List pre and post heat and interpass temperature
    - i. Describe initial and interpass cleaning
    - j. Describe technique which is used
    - k. Produce single or multiple pass weld
    - l. Choose current type
    - m. Set current amperage
    - n. Set current polarity
    - o. Set voltage

WLD-L7-HO6
Apply Welders Identification
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
   - a. Produce end preparations with oxy-fuel cutting
   - b. Produce end preparations with plasma cutting
   - c. Produce end preparations with mechanical cutting
   - d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
   - a. Cut and single bevel pipe to 37 1/2°
   - b. Ground bevel face and touch up to within tolerances
   - c. Check that pipe ends are square within given tolerances
   - d. Prepare root face within given tolerances
   - e. Align pipe to within given tolerances
   - f. Set root opening to within given tolerances
   - g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
   - a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   - b. Weld remainder of pipe in the 1G roll welding position with E6010
   - c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   - a. Weld using 1/8" E6010
   - b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   - c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   - d. Weld root pass to ASME Section 9 requirements
   - e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
   - a. Fit and tack weld pipe to within tolerances
   - b. Place pipe in the 5G position
   - c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
   - d. Grind the finished root pass to remove high spots and any slag at weld toes

- e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
    - a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
    - b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
    - c. Weld remainder of pipe in 1G position using E7018
    - d. Perform low hydrogen starts and stops
    - e. Weld using stringer bead technique
    - f. Weld using weave technique
    - g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
    - a. Use 1/8" E6010
    - b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
    - c. Fit together two pipe ends to a single V edge preparation within given tolerances
    - c. Weld root pass to ASME Section 9 requirements
    - d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
    - e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
    - a. Set up GMAW equipment
    - b. Adjust wire feeder drive system
    - c. Adjust shielding gas system and flow rate
    - d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
    - e. Set welding condition for short circuit transfer - Wire Feed Speed
    - f. Set welding condition for short circuit transfer - Voltage
    - g. Set welding condition for short circuit transfer - Tip to work Distance
    - h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
    - a. Bevel pipe ends
    - b. Touch up bevel face with grinder
    - c. Fit and tack backing ring to one pipe end
    - d. Fit other pipe over backing ring
    - e. Adjust gap and tack in place
    - f. Adjust shielding gas flow
    - g. Adjust wire feed system
    - h. Adjust power source to procedure specification
    - i. Set wire feed speed to procedure specification
    - j. Adjust voltage to procedure specification
    - k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L7-LA
Apply Welders Identification
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: **Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.**

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: **Electrical shock can be avoided by following specific safety precautions.**

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: **Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.**

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: **NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.**
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L7-LW
Apply Welders Identification
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**
   - Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.
   - Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

   Step 1. Choose the proper electrode for the job.

   NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

   The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

   Step 2. Store the electrodes properly.

   a. Low-hydrogen electrodes:

   (1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

   (2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

   (3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

   NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC	Alternating Current
DC+(DCRP)	Direct Current Reverse Polarity
DC-(DCSP)	Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

        - (1) Product design
        - (2) Material thickness
        - (3) Design strength requirements
        - (4) Welding process employed
    - b. SMAW weld joint configuration may be a:
        - (1) Lap joint
        - (2) Tee joint
        - (3) Corner joint
        - (4) Edge joint
        - (5) Butt joint with backing
        - (6) Butt joint without backing
- Step 2. Clean the areas to be welded prior to fit-up
    - a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
    - b. Remove oils and greases with a safe, suitable solvent
- Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.
- Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.
- Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

- Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.
- Step 2. Use any preheat that may be required by welding codes or company procedures.
- Step 3. Make the required weld to be defect free and pleasing in appearance.
- Step 4. Use proper weld bead placement according to the weld joint design.
    - a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
    - b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
    - c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.
- Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

Name ______________________________ Date ____________________________

WLD-L7
Apply Welders Identification
Self-Assessment No. 1

Circle the best answer.

1. What is the approximate temperature required for stress relief annealing of low-carbon steels?
   - A. 950°
   - B. 1000°
   - C. 1950°
   - D. 1700°
   - E. None of the above

2. What crystalline processes result from stress relief annealing?
   - A. All grains reform into softer grains
   - B. Distorted grains reform into softer grains
   - C. Ferrite grains reform into softer grains while pearlite grains are basically unaffected
   - D. Pearlite grains reform into softer grains while ferrite grains are basically unaffected
   - E. None of the above

3. Which of the following is NOT a cause of quenching cracks?
   - A. Improper quenching medium
   - B. Overheating during the austenitizing cycle
   - C. Improper quenching angle
   - D. All of the above are causes of quenching cracks
   - E. None of the above answers is correct

4. Which of the following is NOT a characteristic of typical quench cracks?
   - A. The fracture tends to run from the surface toward the center in a smooth curve
   - B. Untempered quench cracks will not show any decarburization
   - C. Tempered fracture surfaces will show a fine crystalline structure
   - D. All of the above are characteristic of quench cracks
   - E. None of the above

5. During tempering by color, which of the following colors represents the highest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

6. During tempering by color, which of the following colors represents the lowest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

7. What is meant by *step quenching*?
   - A. The workpiece is first quenched in a slow medium (e.g., air) then in a fast medium (e.g., water)
   - B. The workpiece is first quenched in a fast medium (e.g., water) then in a slow medium (e.g., air)
   - C. The weaker parts of the workpiece are quenched separately from the main body of the workpiece
   - D. The workpiece is lowered into the quenching medium in steps so that different parts of the workpiece attain different hardnesses
   - E. None of the above

8. What is the simplest thing that the technician can do to minimize the vapor-blanket stage of liquid quenching?
   - A. Agitate the workpiece or the medium
   - B. Heat the quenching medium to just below its boiling point
   - C. Quickly insert the workpiece into the medium
   - D. Slowly insert the workpiece into the medium
   - E. None of the above

9. Liquid carburizing, as used in case hardening, utilizes __________ and is therefore extremely dangerous.
   - A. Sodium chloride
   - B. Calcium carbonate
   - C. Cyanide salts
   - D. Ammonia
   - E. None of the above

10. Workpieces which have been cut with an oxyacetylene torch often display edge hardness because

A. The torch was starved for oxygen
B. The workpiece was cut at too low a temperature
C. The wrong type of cutting torch was used
D. Oxyacetylene torches always leave hardened edges
E. None of the above

WLD-L7
Apply Welders Identification
Self-Assessment No. 1 Answer Key

1. a
2. c
3. d
4. a
5. c
6. d
7. b
8. a
9. c
10. a

Name ______________________________ Date ____________________

WLD-L7
Apply Welders Identification
Self-Assessment No. 2

Circle the best answer.

1. The *hardness* of a metal is its ability to resist:
    - A. Permanent deformation.
    - B. Oxidation.
    - C. Chemical reaction.
    - D. All of the above answers are forms of hardness.
    - E. None of the above.

2. Rockwell testing machines test the sample metal's resistance to:
    - A. Abrasion.
    - B. Penetration.
    - C. Elastic deformation.
    - D. Electricity.
    - E. None of the above.

3 Materials such as nitrided steel and hard cast irons generally have Rockwell hardness numbers in excess of
    - A. B-50.
    - B. B-75.
    - C. B- 100.
    - D. B-150.
    - E. None of the above.

4. During the file test, if the file will mark the metal but not cut into it, then the metal should be treated as:
    - A. High-alloy steel.
    - B. Mild steel.
    - C. Hardened tool steel.
    - D. Medium-carbon steel.
    - E. None of the above.

5. Probably the best use of the spark test is to:
    - A. Determine the alloy content of the sample.
    - B. Identify cast iron.
    - C. Compare the sample to a known piece.
    - D. All of the above answers are valid.
    - E. None of the above.

6. Tool steel has a Rockwell hardness of __________, while hardened tool steel has hardness number of __________.
   - A. C-42 - C-64
   - B. C-42 - B-65
   - C. C-64 - C-42
   - D. B-65 - C-42
   - E. None of the above.

7. Which of the following surfaces should be avoided when hardness testing?
   - A. Curved
   - B. Rough
   - C. Decarburized
   - D. All of the above surfaces should be modified before testing the sample's hardness.
   - E. None of the above.

8. For hardness testing, the minimum recommended clearance from the edge is:
   - A. 1/2”
   - B. 1/4”
   - C. 1/8”
   - D. 1/16”
   - E. None of the above.

9. If a Rockwell tester is in daily use, it should be calibrated:
   - A. Annually.
   - B. Monthly.
   - C. Weekly.
   - D. Daily.
   - E. Never.

10. Technician A says that, for large samples, multiple hardness test should be made and their results averaged. Technician B says that many materials vary in hardness over the length of the sample. Who is correct?
   - A. Technician A only
   - B. Technician B only
   - C. Both technicians are correct.
   - D. Neither technician is correct.

WLD-L7

Apply Welders Identification

Self-Assessment No. 2 Answer Key

1. a
2. b
3. c
4. c
5. c
6. e
7. d
8. c
9. d
10. d

Name: ______________________________ Date: ___________________________

WLD-L7
Apply Welders Identification
Self-Assessment No. 3

Choose the best answer.

1. The size of the bead is __________ proportional to the speed of travel.
   - A. Directly
   - B. Inversely
   - C. Not
   - D. None of the above

2. The eye shield of the welding helmet should be:
   - A. Just light enough to clearly see the arc.
   - B. Too dark to clearly see the arc.
   - C. A minimum of #5.
   - D. None of the above.

3. Welding in confined spaces may require:
   - A. Air supplied hoods or hose masks.
   - B. Frequent breaks.
   - C. Large, high-displacement fans.
   - D. All of the above.
   - E. None of the above.

4. Long sleeves protect the arms against:
   - A. Ultraviolet radiation.
   - B. Infrared radiation.
   - C. Welding splatter.
   - D. All of the above.
   - E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
   - A. Current polarity
   - B. Arc length
   - C. Length of the electrode
   - D. All of the above are variables in the process.
   - E. None of the above.

6. Acceptable welding footwear includes:
   A. Roman sandals.
   B. Tennis shoes.
   C. Canvas boots.
   D. All of the above.
   E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   A. Excess convexity.
   B. Overlap.
   C. Porosity.
   D. All of the above.
   E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   A. DC-.
   B. DC+.
   C. AC.
   D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
   - A. On.
   - B. Off.
   - C. On or off, depending on the repair.
   - D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
   - A. On rubber work mats.
   - B. Elevated off the floor.
   - C. Grounded.
   - D. All of the above.
   - E. None of the above.

14. Which of the following electrodes is NOT in the low-hydrogen family?
   - A. E7015
   - B. E7016
   - C. E7018
   - D. All of the above are low-hydrogen electrodes.
   - E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
   - A. Technician A only.
   - B. Technician B only.
   - C. Both Technicians A and B.
   - D. Neither Technician A nor B.

16. Fire inspections should be continued for at least __________ after completion of the welding.
   - A. Fifteen minutes
   - B. Thirty minutes
   - C. One hour
   - D. Two hours

17. The welding area should be:
   - A. Isolated from other workers by shields.
   - B. At least 35 feet from combustible materials.
   - C. Dry.
   - D. All of the above.
   - E. None of the above.

18. Seam welds generally require _____________ oscillation.
A. No
B. Very little
C. Moderate
D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?
A. Technician A only.
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:
A. Do not weld
B. Take frequent breaks to inspect the area for fires
C. Station a fire watcher near the combustible materials
D. Any of the above is acceptable
E. None of the above

21. E7018 electrodes should never be used with
A. DC-
B. DC+
C. AC
D. There is no such electrode

22. Areas to be welded should be thoroughly cleaned
A. Prior to fit-up
B. By brushing, sanding, or grinding
C. With safe solvents
D. All of the above, as necessary
E. None of the above

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?
A. Technician A only
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

24. Low-hydrogen electrodes may be stored
   A. In sealed cans or heated rod ovens
   B. Under water
   C. In petroleum jelly
   D. Any of the above
   E. None of the above

25. As the material being welded increases in thickness, the travel speed of the weld must
   A. Increase
   B. Decrease
   C. Either A or B, depending on the desired effect
   D. Stay the same
   E. None of the above

WLD-L7
Apply Welders Identification
Self-Assessment No. 3 Answer Key

1.	b
2.	a
3.	a
4.	d
5.	c
6.	e
7.	e
8.	c
9.	b
10.	c
11.	c
12.	b
13.	c
14.	d
15.	a
16.	b
17.	d
18.	b
19.	c
20.	c
21.	a
22.	d
23.	b
24.	a
25.	b

WELDER SERIES

MASTER Technical Module No. WLD-L08

SUBJECT: **WELDING TECHNICIAN** **TIME: 8 HOURS**

- **DUTY:** **SHIELDED METAL ARC WELDING (SMAW) (BASIC)**
- **TASK:** Control Post-Weld Temperature According to Procedures

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify welding procedure specification;
B. Use welding current or flame to control temperature; and,
C. Use temperature stick or other indicators to indicate temperatures.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on control of post-weld temperatures
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video materials
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Shielded Metal Arc Welding machine
Welding shop tools
Selection of base metals for welding and cutting
Selection of filler metals and electrode wire
MASTER Handout No. 1 (WLD-L8-HO1)
MASTER Handout No. 2 (WLD-L8-HO2)
MASTER Handout No. 3 (WLD-L8-HO3)
MASTER Handout No. 4 (WLD-L8-HO4)
MASTER Handout No. 5 (WLD-L8-HO5)
MASTER Handout No. 6 (WLD-L8-HO6)
MASTER Laboratory Aid (WLD-L8-LA)
MASTER Laboratory Worksheet (WLD-L8-LW)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition

Reading Welding Blueprints & Symbols, Stinchcomb, Craig, New Jersey: Prentice-Hall, Inc., Latest Edition

Certification Manual For Welding Inspector, American Welding Society, Miami, FL, (ISBN 0-87171-421-3) Latest Edition

Welding Qualifications, Practical Guide to ASME Section IX, Houle, Michael J., *CASTI* Publishing, Inc., Canada, (ISBN 0-9696428-5-7), Latest Edition

The Procedure Handbook of Arc Welding; The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students will complete the following modules:

WLD-L1	"Preheat Joint"
WLD-L2	"Initiate Welding Process"
WLD-L3	"Perform Weld Sequence"
WLD-L4	"Control Weld Technique"
WLD-L5	"Maintain Preheat and Perform Interpass"
WLD-L6	"Use the Carbon Arc Process to Cut and Gouge Weld Materials"
WLD-L7	"Apply Welders Identification"

INTRODUCTION:

The Course Introduction will Include:

- An overview of temperature control procedures for post weld operations
- A class demonstration of effective temperature controls
- Use of indicators to determine temperatures

PRESENTATION OUTLINE:

Instructor Topics:

A. Welding Procedure Specifications
B. Preheat and interpass temperatures may be specified as:
  1. Minimum temperatures only (mild carbon steel with no special requirements)
  2. Maximum temperature only (aluminum and nickel alloys)
  3. Minimum and maximum temperatures (low alloy steels with impact requirements)
C. Tempering and Stress relieving in post weld heat treatment
D. Heating area and Holding time
E. Cooling rates
F. Applicable Codes and Specifications
G. Heat sources and temperature indication tools must not adversely affect weldment

Student Activities:

A. Heating and cooling materials, following welding procedure specifications
B. Use of heat sources and temperature indicators
C. Making adjustments to improve weld quality
D. Observation of the use of welding procedures during field trip

PRACTICAL APPLICATION:

Control of post weld temperatures is a procedural reality in a quality work environment with welding procedures and specifications. Welding procedures and specifications are requirements, not advisory in nature. Upon employment students must follow welding procedures with particular care during production operations.

EVALUATION AND/OR VERIFICATION:

Written examinations will be given in this module to determine student progress. Students will see typical instructions used in a manufacturing environment during a field trip using welding procedures specifications.

SUMMARY:

Welding procedures and specifications are requirements, not advisory in nature. Students must follow them with particular care during production operations.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-L9) dealing with post cleaning weld.

WLD-L8-HO1

Control Post-Weld Temperature According to Procedures

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- A. Identify welding procedure specification;
- B. Use welding current or flame to control temperature; and,
- C. Use temperature stick or other indicators to indicate temperatures.

MODULE OUTLINE:

Instructor Topics:

- A. Welding Procedure Specifications
- B. Preheat and interpass temperatures may be specified as:
  - 1. Minimum temperatures only (mild carbon steel with no special requirements)
  - 2. Maximum temperature only (aluminum and nickel alloys)
  - 3. Minimum and maximum temperatures (low alloy steels with impact requirements)
- C. Tempering and Stress relieving in post weld heat treatment
- D. Heating area and Holding time
- E. Cooling rates
- F. Applicable Codes and Specifications
- G. Heat sources and temperature indication tools must not adversely affect weldment

Student Activities:

- A. Heating and cooling materials, following welding procedure specifications
- B. Use of heat sources and temperature indicators
- C. Making adjustments to improve weld quality
- D. Observation of the use of welding procedures during field trip

WLD-L8-HO2

Control Post-Weld Temperature According to Procedures

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
  A. Hardening for utility
  B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  A. Brine (water and sodium chloride or sodium hydroxide)
  B. Water
  C. Fused (liquid) salts
  D. Molten lead
  E. Soluble oil and water
  F. Oil
  G. Air
IV. Estimate Metal Heat Temperature by Color
  A. Use of temper color chart for tempering
  B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L8-HO3
Control Post-Weld Temperature According to Procedures
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
    A. Imprecise method, good for rough estimates only
    B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
    A. High-carbon steels show more spark bursts than do low-carbon steels
    B. Non-ferrous metals
        1. Aluminum
        2. Magnesium
        3. Brass
        4. Bronze
        5. Nickel
        6. Tin
        7. Others
III. Perform Rockwell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
    A. Ferrous metals
    B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L8-HO4
Control Post-Weld Temperature According to Procedures
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

    - c. Verbally warn others of intent to arc weld
    - d. Strike an arc
    - e. Weld with stringer bead technique
    - f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
    - a. Maintain required weld quality
    - b. Maintain proper weld width uniformly
    - c. Maintain proper travel speed
    - d. Match correct oscillation for various electrodes
    - e. Match applications to weave techniques, as they apply
    - f. List the advantages and disadvantages of weave techniques
    - g. List the advantages and disadvantages of stringer techniques
    - h. Perform weld using weave technique
    - i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
    - a. Weld a dam to outline area being welded for each layer
    - b. Apply each layer neatly, straight and with good fusion throughout
    - c. Chip slag after each pass
    - d. Weld passes which over lap to crown of last weld bead
    - e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
    - a. Follow manufacturer's recommended practice
    - b. Inspect equipment and work area for safety
    - c. Assemble oxy-fuel equipment
    - d. Open fuel gas cylinder ½ turn
    - e. Open oxygen as cylinder all the way
    - f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
    - g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    - a. Make manual free hand straight line cuts
    - b. Cut manually straight lines using cutting jib
    - c. Bevel plate with manual oxy-fuel equipment
    - d. Manually cut blind holes in thick material
    - e. Manually cut sheet metal with minimal distortion

WLD-L8-HO5

Control Post-Weld Temperature According to Procedures

Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
   a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
   b. Use grinder to remove oxide larger and smooth plate
   c. Use grinder to create root face of 3/32" to 1/8"
   d. Tack single V groove joint with 3/32" root opening
   e. Place joint in the 1G position
   f. Place joint in 2G position once task is mastered
   g. Place joint in 3G position once task is mastered
   h. Place joint in 4G position once task is mastered
   i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
   j. Weld chipped side slag and the root bead is wire brushed
   k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
   l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
   a. Inspect area for safety
   b. Place plate flat on welding table
   c. Place 3" pipe vertically on top of plate and tacked in place
   d. Leave weld coupon in the 2F fixed position
   e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
   f. Visually inspect weld to AWS D1.1
   g. Fill pipe with water for 24 hours
   h. Check for leak
3. Produce SMAW Pipe - 5G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening

- g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
- h. Chip slag and wire brush weld
- i. Grind any lack of fusion and/or high spots
- j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
- k. Visually inspect weld on the root and face sides to ASME Section 9
- l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   - a. Measure the pipe
   - b. Mark the cut line with a wrap around and soapstone
   - c. Cut the bevel using oxy-fuel gas equipment
   - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Tack the single V groove pipe joint with a 3/32" root opening
   - g. Weld pipe joint
   - h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   - i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   - j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   - k. Visually inspect weld on the root and face sides to ASME Section 9
   - l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
   - a. Measure the pipe
   - b. Mark the cut line with a wrap around and soapstone
   - c. Cut the bevel using oxy-fuel gas equipment
   - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Tack the single V groove pipe joint with a 3/32" root opening
   - g. Roll weld pipe
   - h. Place pipe coupon on workbench in the 1G roll welding position.
   - i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   - j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

- k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
- l. Visually inspect weld on the root and face sides to ASME Section 9
- m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   - a. Measure the pipe and
   - b. Mark the cut line with a wrap around and soapstone
   - c. Cut the bevel using oxy-fuel gas equipment
   - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Weld pipe
   - g. Tack the single V groove pipe joint with a 3/32" root opening
   - h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   - i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   - j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   - k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   - l. Visually inspect weld on the root and face sides to ASME Section 9
   - m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
7. Produce SMAW Pipe - 6G Position
   - a. Measure the pipe
   - b. Mark the cut line with a wrap around and soapstone
   - c. Cut the bevel using oxy-fuel gas equipment
   - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Tack the single V groove pipe joint with a 3/32" root opening
   - g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   - h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   - i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   - j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   - k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L8-HO6
Control Post-Weld Temperature According to Procedures
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    a. Produce end preparations with oxy-fuel cutting
    b. Produce end preparations with plasma cutting
    c. Produce end preparations with mechanical cutting
    d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    a. Cut and single bevel pipe to 37 1/2°
    b. Ground bevel face and touch up to within tolerances
    c. Check that pipe ends are square within given tolerances
    d. Prepare root face within given tolerances
    e. Align pipe to within given tolerances
    f. Set root opening to within given tolerances
    g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    b. Weld remainder of pipe in the 1G roll welding position with E6010
    c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    a. Weld using 1/8" E6010
    b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    d. Weld root pass to ASME Section 9 requirements
    e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    a. Fit and tack weld pipe to within tolerances
    b. Place pipe in the 5G position
    c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
    d. Grind the finished root pass to remove high spots and any slag at weld toes

- e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   - a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   - b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   - c. Weld remainder of pipe in 1G position using E7018
   - d. Perform low hydrogen starts and stops
   - e. Weld using stringer bead technique
   - f. Weld using weave technique
   - g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   - a. Use 1/8" E6010
   - b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   - c. Fit together two pipe ends to a single V edge preparation within given tolerances
   - c. Weld root pass to ASME Section 9 requirements
   - d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   - e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
   - a. Set up GMAW equipment
   - b. Adjust wire feeder drive system
   - c. Adjust shielding gas system and flow rate
   - d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   - e. Set welding condition for short circuit transfer - Wire Feed Speed
   - f. Set welding condition for short circuit transfer - Voltage
   - g. Set welding condition for short circuit transfer - Tip to work Distance
   - h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
   - a. Bevel pipe ends
   - b. Touch up bevel face with grinder
   - c. Fit and tack backing ring to one pipe end
   - d. Fit other pipe over backing ring
   - e. Adjust gap and tack in place
   - f. Adjust shielding gas flow
   - g. Adjust wire feed system
   - h. Adjust power source to procedure specification
   - i. Set wire feed speed to procedure specification
   - j. Adjust voltage to procedure specification
   - k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	Minimum Shade No.	Suggested Shade*
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L8-LW
Control Post-Weld Temperature According to Procedures
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:
AC Alternating Current
DC+(DCRP) Direct Current Reverse Polarity
DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010. E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

    - (1) Product design
    - (2) Material thickness
    - (3) Design strength requirements
    - (4) Welding process employed
  - b. SMAW weld joint configuration may be a:
    - (1) Lap joint
    - (2) Tee joint
    - (3) Corner joint
    - (4) Edge joint
    - (5) Butt joint with backing
    - (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
  - a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
  - b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
  - a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
  - b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
  - c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.
b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

Name ______________________________ Date ____________________________

WLD-L8
Control Post-Weld Temperature According to Procedures
Self-Assessment No. 1

Circle the best answer.

1. What is the approximate temperature required for stress relief annealing of low-carbon steels?
   A. 950°
   B. 1000°
   C. 1950°
   D. 1700°
   E. None of the above

2. What crystalline processes result from stress relief annealing?
   A. All grains reform into softer grains
   B. Distorted grains reform into softer grains
   C. Ferrite grains reform into softer grains while pearlite grains are basically unaffected
   D. Pearlite grains reform into softer grains while ferrite grains are basically unaffected
   E. None of the above

3. Which of the following is NOT a cause of quenching cracks?
   A. Improper quenching medium
   B. Overheating during the austenitizing cycle
   C. Improper quenching angle
   D. All of the above are causes of quenching cracks
   E. None of the above answers is correct

4. Which of the following is NOT a characteristic of typical quench cracks?
   A. The fracture tends to run from the surface toward the center in a smooth curve
   B. Untempered quench cracks will not show any decarburization
   C. Tempered fracture surfaces will show a fine crystalline structure
   D. All of the above are characteristic of quench cracks
   E. None of the above

5. During tempering by color, which of the following colors represents the highest temperature?

A. Gold
B. Purple
C. Dark Straw
D. Pale Blue
E. Violet

6. During tempering by color, which of the following colors represents the lowest temperature?

A. Gold
B. Purple
C. Dark Straw
D. Pale Blue
E. Violet

7. What is meant by *step quenching*?

A. The workpiece is first quenched in a slow medium (e.g., air) then in a fast medium (e.g., water)
B. The workpiece is first quenched in a fast medium (e.g., water) then in a slow medium (e.g., air)
C. The weaker parts of the workpiece are quenched separately from the main body of the workpiece
D. The workpiece is lowered into the quenching medium in steps so that different parts of the workpiece attain different hardnesses
E. None of the above

8. What is the simplest thing that the technician can do to minimize the vapor-blanket stage of liquid quenching?

A. Agitate the workpiece or the medium
B. Heat the quenching medium to just below its boiling point
C. Quickly insert the workpiece into the medium
D. Slowly insert the workpiece into the medium
E. None of the above

9. Liquid carburizing, as used in case hardening, utilizes __________ and is therefore extremely dangerous.

A. Sodium chloride
B. Calcium carbonate
C. Cyanide salts
D. Ammonia
E. None of the above

10. Workpieces which have been cut with an oxyacetylene torch often display edge hardness because

A. The torch was starved for oxygen
B. The workpiece was cut at too low a temperature
C. The wrong type of cutting torch was used
D. Oxyacetylene torches always leave hardened edges
E. None of the above

WLD-L8

Control Post-Weld Temperature According to Procedures

Self-Assessment No. 1 Answer Key

1. a
2. c
3. d
4. a
5. c
6. d
7. b
8. a
9. c
10. a

Name ______________________________ Date ____________________

WLD-L8
Control Post-Weld Temperature According to Procedures
Self-Assessment No. 2

Circle the best answer.

1. The *hardness* of a metal is its ability to resist:
    - A. Permanent deformation.
    - B. Oxidation.
    - C. Chemical reaction.
    - D. All of the above answers are forms of hardness.
    - E. None of the above.

2. Rockwell testing machines test the sample metal's resistance to:
    - A. Abrasion.
    - B. Penetration.
    - C. Elastic deformation.
    - D. Electricity.
    - E. None of the above.

3. Materials such as nitrided steel and hard cast irons generally have Rockwell hardness numbers in excess of
    - A. B-50
    - B. B-75
    - C. B- 100
    - D. B-150
    - E None of the above.

4. During the file test, if the file will mark the metal but not cut into it, then the metal should be treated as:
    - A. High-alloy steel.
    - B Mild steel.
    - C. Hardened tool steel.
    - D. Medium-carbon steel.
    - E. None of the above.

5. Probably the best use of the spark test is to:
    - A. Determine the alloy content of the sample.
    - B. Identify cast iron.
    - C. Compare the sample to a known piece.
    - D. All of the above answers are valid.
    - E. None of the above.

6. Tool steel has a Rockwell hardness of __________, while hardened tool steel has hardness number of __________.
   - A. C-42 - C-64
   - B. C-42 - B-65
   - C. C-64 - C-42
   - D. B-65 - C-42
   - E. None of the above.

7. Which of the following surfaces should be avoided when hardness testing?
   - A. Curved
   - B. Rough
   - C. Decarburized
   - D. All of the above surfaces should be modified before testing the sample's hardness.
   - E. None of the above.

8. For hardness testing, the minimum recommended clearance from the edge is:
   - A. 1/2"
   - B. 1/4"
   - C. 1/8"
   - D. 1/16"
   - E. None of the above.

9. If a Rockwell tester is in daily use, it should be calibrated:
   - A. Annually.
   - B. Monthly.
   - C. Weekly.
   - D. Daily.
   - E. Never.

10. Technician A says that, for large samples, multiple hardness test should be made and their results averaged. Technician B says that many materials vary in hardness over the length of the sample. Who is correct?
   - A. Technician A only
   - B. Technician B only
   - C. Both technicians are correct.
   - D. Neither technician is correct.

WLD-L8

Control Post-Weld Temperature According to Procedures

Self-Assessment No. 2 Answer Key

1. a

2. b

3. c

4. c

5. c

6. e

7. d

8. c

9. d

10. d

Name: ______________________________ Date: ___________________________

WLD-L8
Control Post-Weld Temperature According to Procedures
Self-Assessment No. 3

Choose the best answer.

1. The size of the bead is __________ proportional to the speed of travel.
   - A. Directly
   - B. Inversely
   - C. Not
   - D. None of the above

2. The eye shield of the welding helmet should be:
   - A. Just light enough to clearly see the arc.
   - B. Too dark to clearly see the arc.
   - C. A minimum of #5.
   - D. None of the above.

3. Welding in confined spaces may require:
   - A. Air supplied hoods or hose masks.
   - B. Frequent breaks.
   - C. Large, high-displacement fans.
   - D. All of the above.
   - E. None of the above.

4. Long sleeves protect the arms against:
   - A. Ultraviolet radiation.
   - B. Infrared radiation.
   - C. Welding splatter.
   - D. All of the above.
   - E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
   - A. Current polarity
   - B. Arc length
   - C. Length of the electrode
   - D. All of the above are variables in the process.
   - E. None of the above.

6. Acceptable welding footwear includes:
   A. Roman sandals.
   B. Tennis shoes.
   C. Canvas boots.
   D. All of the above.
   E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   A. Excess convexity.
   B. Overlap.
   C. Porosity.
   D. All of the above.
   E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   A. DC-.
   B. DC+.
   C. AC.
   D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
   - A. On.
   - B. Off.
   - C. On or off, depending on the repair.
   - D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
   - A. On rubber work mats.
   - B. Elevated off the floor.
   - C. Grounded.
   - D. All of the above.
   - E. None of the above.

14. Which of the following electrodes is NOT in the low-hydrogen family?
   - A. E7015
   - B. E7016
   - C. E7018
   - D. All of the above are low-hydrogen electrodes.
   - E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
   - A. Technician A only.
   - B. Technician B only.
   - C. Both Technicians A and B.
   - D. Neither Technician A nor B.

16. Fire inspections should be continued for at least __________ after completion of the welding.
   - A. Fifteen minutes
   - B. Thirty minutes
   - C. One hour
   - D. Two hours

17. The welding area should be:
   - A. Isolated from other workers by shields.
   - B. At least 35 feet from combustible materials.
   - C. Dry.
   - D. All of the above.
   - E. None of the above.

18. Seam welds generally require _____________ oscillation.
    - A. No
    - B. Very little
    - C. Moderate
    - D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?
    - A. Technician A only.
    - B. Technician B only
    - C. Both Technicians A and B
    - D. Neither Technician A nor B

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:
    - A. Do not weld
    - B. Take frequent breaks to inspect the area for fires
    - C. Station a fire watcher near the combustible materials
    - D. Any of the above is acceptable
    - E. None of the above

21. E7018 electrodes should never be used with
    - A. DC-
    - B. DC+
    - C. AC
    - D. There is no such electrode

22. Areas to be welded should be thoroughly cleaned
    - A. Prior to fit-up
    - B. By brushing, sanding, or grinding
    - C. With safe solvents
    - D. All of the above, as necessary
    - E. None of the above

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?
    - A. Technician A only
    - B. Technician B only
    - C. Both Technicians A and B
    - D. Neither Technician A nor B

24. Low-hydrogen electrodes may be stored
    A. In sealed cans or heated rod ovens
    B. Under water
    C. In petroleum jelly
    D. Any of the above
    E. None of the above

25. As the material being welded increases in thickness, the travel speed of the weld must
    A. Increase
    B. Decrease
    C. Either A or B, depending on the desired effect
    D. Stay the same
    E. None of the above

WLD-L8

Control Post-Weld Temperature According to Procedures

Self-Assessment No. 3 Answer Key

1. b
2. a
3. a
4. d
5. c
6. e
7. e
8. c
9. b
10. c
11. c
12. b
13. c
14. d
15. a
16. b
17. d
18. b
19. c
20. c
21. a
22. d
23. b
24. a
25. b

WELDER SERIES

MASTER Technical Module No. WLD-L09

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **SHIELDED METAL ARC WELDING (SMAW) (BASIC)**
- **TASK:** Post Clean Weld

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify material not associated with weld metal;
B. Use a variety of tools to remove residue material; and,
C. Identify when all slag, etc., is removed.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on cleaning processes after welding
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video materials
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Shielded Metal Arc Welding machine
Welding shop tools
Selection of base metals for welding and cutting
Selection of filler metals and electrode wire
MASTER Handout No. 1 (WLD-L9-HO1)
MASTER Handout No. 2 (WLD-L9-HO2)
MASTER Handout No. 3 (WLD-L9-HO3)
MASTER Handout No. 4 (WLD-L9-HO4)
MASTER Handout No. 5 (WLD-L9-HO5)
MASTER Handout No. 6 (WLD-L9-HO6)
MASTER Laboratory Aid (WLD-L9-LA)
MASTER Laboratory Worksheet (WLD-L9-LW)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition

Reading Welding Blueprints & Symbols, Stinchcomb, Craig, New Jersey: Prentice-Hall, Inc., Latest Edition

Certification Manual For Welding Inspector, American Welding Society, Miami, FL, (ISBN 0-87171-421-3) Latest Edition

Welding Qualifications, Practical Guide to ASME Section IX, Houle, Michael J., *CASTI* Publishing, Inc., Canada, (ISBN 0-9696428-5-7), Latest Edition

The Procedure Handbook of Arc Welding; The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses.

WLD-L1	"Preheat Joint"
WLD-L2	"Initiate Welding Process"
WLD-L3	"Perform Weld Sequence"
WLD-L4	"Control Weld Technique"
WLD-L5	"Maintain Preheat and Perform Interpass"
WLD-L6	"Use the Carbon Arc Process to Cut and Gouge Weld Materials"
WLD-L7	"Apply Welders Identification"
WLD-L8	"Control Post-Weld Temperature According to Procedures"

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need for post weld operations and weld cleaning procedures
- A class demonstration of effective weld cleaning techniques
- A discussion on activities resulting in further training and an increase of skill and knowledge leading to certification in related program areas.

PRESENTATION OUTLINE:

Instructor Topics:

A. Joint preparation and cleaning of surfaces for welding
B. Post cleaning of weld following welding procedure specifications
C. Examples of cleaning processes followed by major manufacturers
D. Demonstrate knowledge of the proper application of welding skills

Student Activities:

A. Joint preparations and metal cleaning of surfaces for welding
B. Oxygen cutting, air carbon arc, or plasma cutting (may involve marking or grinding followed by cleaning
C. Post cleaning of weld (with examples from major industries of specific products and cleaning methods
D. Oxide layers may be removed by grinding, sanding, or stainless brushing

PRACTICAL APPLICATION:

The student needs to know and fully appreciate the importance of all steps in welding procedure specification. The alternatives may be costly rework or rejection of product by customers.

EVALUATION AND/OR VERIFICATION:

Written examinations will be given in this module to determine student progress. Practical exercises will be evaluated by student and instructor.

SUMMARY:

Many industries have welded products that are marketed to customers in aerospace, pressure vessel, and aviation sectors that demand top quality in the welding procedures and post weld treatment processes that are critical to product outcomes.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-L10) dealing with post finishing weld.

WLD-L9-HO1
Post Clean Weld
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Identify material not associated with weld metal;
B. Use a variety of tools to remove residue material; and,
C. Identify when all slag, etc., is removed.

MODULE OUTLINE:

Instructor Topics:
A. Joint preparation and cleaning of surfaces for welding
B. Post cleaning of weld following welding procedure specifications
C. Examples of cleaning processes followed by major manufacturers
D. Demonstrate knowledge of the proper application of welding skills

Student Activities:
A. Joint preparations and metal cleaning of surfaces for welding
B. Oxygen cutting, air carbon arc, or plasma cutting (may involve marking or grinding followed by cleaning
C. Post cleaning of weld (with examples from major industries of specific products and cleaning methods
D. Oxide layers may be removed by grinding, sanding, or stainless brushing

WLD-L9-HO2
Post Clean Weld
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
  A. Hardening for utility
  B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  A. Brine (water and sodium chloride or sodium hydroxide)
  B. Water
  C. Fused (liquid) salts
  D. Molten lead
  E. Soluble oil and water
  F. Oil
  G. Air
IV. Estimate Metal Heat Temperature by Color
  A. Use of temper color chart for tempering
  B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L9-HO3
Post Clean Weld
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
  A. Imprecise method, good for rough estimates only
  B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
  A. High-carbon steels show more spark bursts than do low-carbon steels.
  B. Non-ferrous metals
    1. Aluminum
    2. Magnesium
    3. Brass
    4. Bronze
    5. Nickel
    6. Tin
    7. Others
III. Perform Rockwell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
  A. Ferrous metals
  B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L9-HO4
Post Clean Weld
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
   a. Define arc welding process terms
   b. Define standard joint terminology
   c. Define common weld discontinuities
   d. Name welding equipment, supply and consumables
   e. Define common shop terms including proper equipment names
   f. Define material terms
   g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
   a. List, describe and define
   b. List low hydrogen electrodes
   c. List iron powder electrodes
   d. Describe electrode by welding position
   e. Describe electrode by current and polarity
   f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
   a. List polarities for commonly used electrodes
   b. Describe both polarities
   c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
   a. Describe and demonstrate start for non-low hydrogen SMAW electrode
   b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
   c. List reasons for the importance of low hydrogen in weld metal
   d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
   a. Inspect area for safety
   b. Adjust current and polarity for specific job requirements
   c. Choose type and size of electrode
   d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
   a. Stand and position oneself correctly
   b. Operate welding helmet

   c. Verbally warn others of intent to arc weld
   d. Strike an arc
   e. Weld with stringer bead technique
   f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    a. Make manual free hand straight line cuts
    b. Cut manually straight lines using cutting jib
    c. Bevel plate with manual oxy-fuel equipment
    d. Manually cut blind holes in thick material
    e. Manually cut sheet metal with minimal distortion

WLD-L9-HO5
Post Clean Weld
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    - a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    - b. Use grinder to remove oxide larger and smooth plate
    - c. Use grinder to create root face of 3/32" to 1/8"
    - d. Tack single V groove joint with 3/32" root opening
    - e. Place joint in the 1G position
    - f. Place joint in 2G position once task is mastered
    - g. Place joint in 3G position once task is mastered
    - h. Place joint in 4G position once task is mastered
    - i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    - j. Weld chipped side slag and the root bead is wire brushed
    - k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    - l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    - a. Inspect area for safety
    - b. Place plate flat on welding table
    - c. Place 3" pipe vertically on top of plate and tacked in place
    - d. Leave weld coupon in the 2F fixed position
    - e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    - f. Visually inspect weld to AWS D1.1
    - g. Fill pipe with water for 24 hours
    - h. Check for leak
3. Produce SMAW Pipe - 5G Position
    - a. Measure the pipe
    - b. Mark the cut line with a wrap around and soapstone
    - c. Cut the bevel using oxy-fuel gas equipment
    - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    - e. Use the grinder to add a root face of from 3/32" to 1/8"
    - f. Tack the single V groove pipe joint with a 3/32" root opening

- g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
- h. Chip slag and wire brush weld
- i. Grind any lack of fusion and/or high spots
- j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
- k. Visually inspect weld on the root and face sides to ASME Section 9
- l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
    - a. Measure the pipe
    - b. Mark the cut line with a wrap around and soapstone
    - c. Cut the bevel using oxy-fuel gas equipment
    - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    - e. Use the grinder to add a root face of from 3/32" to 1/8"
    - f. Tack the single V groove pipe joint with a 3/32" root opening
    - g. Weld pipe joint
    - h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    - i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    - j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    - k. Visually inspect weld on the root and face sides to ASME Section 9
    - l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
    - a. Measure the pipe
    - b. Mark the cut line with a wrap around and soapstone
    - c. Cut the bevel using oxy-fuel gas equipment
    - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    - e. Use the grinder to add a root face of from 3/32" to 1/8"
    - f. Tack the single V groove pipe joint with a 3/32" root opening
    - g. Roll weld pipe
    - h. Place pipe coupon on workbench in the 1G roll welding position.
    - i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
    - j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f List filler material (if required), classification and specification
    g Identify shielding gas - type and mixture
    h List pre and post heat and interpass temperature
    i Describe initial and interpass cleaning
    j Describe technique which is used
    k Produce single or multiple pass weld
    l Choose current type
    m Set current amperage
    n Set current polarity
    o Set voltage

WLD-L9-HO6
Post Clean Weld
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
   a. Produce end preparations with oxy-fuel cutting
   b. Produce end preparations with plasma cutting
   c. Produce end preparations with mechanical cutting
   d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
   a. Cut and single bevel pipe to 37 1/2°
   b. Ground bevel face and touch up to within tolerances
   c. Check that pipe ends are square within given tolerances
   d. Prepare root face within given tolerances
   e. Align pipe to within given tolerances
   f. Set root opening to within given tolerances
   g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
   a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   b. Weld remainder of pipe in the 1G roll welding position with E6010
   c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   a. Weld using 1/8" E6010
   b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   d. Weld root pass to ASME Section 9 requirements
   e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
   a. Fit and tack weld pipe to within tolerances
   b. Place pipe in the 5G position
   c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
   d. Grind the finished root pass to remove high spots and any slag at weld toes

   e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   c. Weld remainder of pipe in 1G position using E7018
   d. Perform low hydrogen starts and stops
   e. Weld using stringer bead technique
   f. Weld using weave technique
   g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   a. Use 1/8" E6010
   b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   c. Fit together two pipe ends to a single V edge preparation within given tolerances
   c. Weld root pass to ASME Section 9 requirements
   d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
   a. Set up GMAW equipment
   b. Adjust wire feeder drive system
   c. Adjust shielding gas system and flow rate
   d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   e. Set welding condition for short circuit transfer - Wire Feed Speed
   f. Set welding condition for short circuit transfer - Voltage
   g. Set welding condition for short circuit transfer - Tip to work Distance
   h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
   a. Bevel pipe ends
   b. Touch up bevel face with grinder
   c. Fit and tack backing ring to one pipe end
   d. Fit other pipe over backing ring
   e. Adjust gap and tack in place
   f. Adjust shielding gas flow
   g. Adjust wire feed system
   h. Adjust power source to procedure specification
   i. Set wire feed speed to procedure specification
   j. Adjust voltage to procedure specification
   k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L9-LA
Post Clean Weld
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	Minimum Shade No.	Suggested Shade*
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L9-LW
Post Clean Weld
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:
AC Alternating Current
DC+(DCRP) Direct Current Reverse Polarity
DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

        - (1) Product design
        - (2) Material thickness
        - (3) Design strength requirements
        - (4) Welding process employed
    - b. SMAW weld joint configuration may be a:
        - (1) Lap joint
        - (2) Tee joint
        - (3) Corner joint
        - (4) Edge joint
        - (5) Butt joint with backing
        - (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up

- a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
- b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1 Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2 Use any preheat that may be required by welding codes or company procedures.

Step 3 Make the required weld to be defect free and pleasing in appearance.

Step 4 Use proper weld bead placement according to the weld joint design.

- a When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
- b When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
- c When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5 Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

Name ______________________________ Date ____________________________

WLD-L9
Post Clean Weld
Self-Assessment No. 1

Circle the best answer.

1. What is the approximate temperature required for stress relief annealing of low-carbon steels?
   - A. 950°
   - B. 1000°
   - C. 1950°
   - D. 1700°
   - E. None of the above

2. What crystalline processes result from stress relief annealing?
   - A. All grains reform into softer grains
   - B. Distorted grains reform into softer grains
   - C. Ferrite grains reform into softer grains while pearlite grains are basically unaffected
   - D. Pearlite grains reform into softer grains while ferrite grains are basically unaffected
   - E. None of the above

3. Which of the following is NOT a cause of quenching cracks?
   - A. Improper quenching medium
   - B. Overheating during the austenitizing cycle
   - C. Improper quenching angle
   - D. All of the above are causes of quenching cracks
   - E. None of the above answers is correct

4. Which of the following is NOT a characteristic of typical quench cracks?
   - A. The fracture tends to run from the surface toward the center in a smooth curve
   - B. Untempered quench cracks will not show any decarburization
   - C. Tempered fracture surfaces will show a fine crystalline structure
   - D. All of the above are characteristic of quench cracks
   - E. None of the above

5. During tempering by color, which of the following colors represents the highest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

6. During tempering by color, which of the following colors represents the lowest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

7. What is meant by *step quenching*?
   - A. The workpiece is first quenched in a slow medium (e.g., air) then in a fast medium (e.g., water)
   - B. The workpiece is first quenched in a fast medium (e.g., water) then in a slow medium (e.g., air)
   - C. The weaker parts of the workpiece are quenched separately from the main body of the workpiece
   - D. The workpiece is lowered into the quenching medium in steps so that different parts of the workpiece attain different hardnesses
   - E. None of the above

8. What is the simplest thing that the technician can do to minimize the vapor-blanket stage of liquid quenching?
   - A. Agitate the workpiece or the medium
   - B. Heat the quenching medium to just below its boiling point
   - C. Quickly insert the workpiece into the medium
   - D. Slowly insert the workpiece into the medium
   - E. None of the above

9. Liquid carburizing, as used in case hardening, utilizes __________ and is therefore extremely dangerous.
   - A. Sodium chloride
   - B. Calcium carbonate
   - C. Cyanide salts
   - D. Ammonia
   - E. None of the above

10. Workpieces which have been cut with an oxyacetylene torch often display edge hardness because

A. The torch was starved for oxygen
B. The workpiece was cut at too low a temperature
C. The wrong type of cutting torch was used
D. Oxyacetylene torches always leave hardened edges
E. None of the above

WLD-L9
Post Clean Weld
Self-Assessment No. 1 Answer Key

1.	a
2.	c
3.	d
4.	a
5.	c
6.	d
7.	b
8.	a
9.	c
10.	a

Name ________________________________ Date ____________________

WLD-L9
Post Clean Weld
Self-Assessment No. 2

Circle the best answer.

1. The *hardness* of a metal is its ability to resist:
   A. Permanent deformation.
   B. Oxidation.
   C. Chemical reaction.
   D. All of the above answers are forms of hardness
   E. None of the above.

2. Rockwell testing machines test the sample metal's resistance to:
   A. Abrasion.
   B. Penetration.
   C. Elastic deformation.
   D. Electricity.
   E. None of the above.

3. Materials such as nitrided steel and hard cast irons generally have Rockwell hardness numbers in excess of
   A. B-50.
   B. B-75.
   C. B- 100.
   D. B-150.
   E. None of the above.

4. During the file test, if the file will mark the metal but not cut into it, then the metal should be treated as:
   A. High-alloy steel.
   B. Mild steel.
   C. Hardened tool steel.
   D. Medium-carbon steel.
   E. None of the above.

5. Probably the best use of the spark test is to:
   A. Determine the alloy content of the sample.
   B. Identify cast iron.
   C. Compare the sample to a known piece.
   D. All of the above answers are valid.
   E. None of the above.

6. Tool steel has a Rockwell hardness of __________, while hardened tool steel has hardness number of __________.
   - A. C-42 - C-64
   - B. C-42 - B-65
   - C. C-64 - C-42
   - D. B-65 - C-42
   - E. None of the above.

7. Which of the following surfaces should be avoided when hardness testing?
   - A. Curved
   - B. Rough
   - C. Decarburized
   - D. All of the above surfaces should be modified before testing the sample's hardness.
   - E. None of the above.

8. For hardness testing, the minimum recommended clearance from the edge is:
   - A. 1/2"
   - B. 1/4"
   - C. 1/8"
   - D. 1/16"
   - E. None of the above.

9. If a Rockwell tester is in daily use, it should be calibrated:
   - A. Annually.
   - B. Monthly.
   - C. Weekly.
   - D. Daily.
   - E. Never.

10. Technician A says that, for large samples, multiple hardness test should be made and their results averaged. Technician B says that many materials vary in hardness over the length of the sample. Who is correct?
    - A. Technician A only
    - B. Technician B only
    - C. Both technicians are correct.
    - D. Neither technician is correct.

WLD-L9

Post Clean Weld

Self-Assessment No. 2 Answer Key

1. a
2. b
3. c
4. c
5. c
6. e
7. d
8. c
9. d
10. d

Name: ______________________________ Date: ___________________________

WLD-L9
Post Clean Weld
Self-Assessment No. 3

Choose the best answer.

1. The size of the bead is __________ proportional to the speed of travel.
   - A. Directly
   - B. Inversely
   - C. Not
   - D. None of the above

2. The eye shield of the welding helmet should be:
   - A. Just light enough to clearly see the arc.
   - B. Too dark to clearly see the arc.
   - C. A minimum of #5.
   - D. None of the above.

3. Welding in confined spaces may require:
   - A. Air supplied hoods or hose masks.
   - B. Frequent breaks.
   - C. Large, high-displacement fans.
   - D. All of the above.
   - E. None of the above.

4. Long sleeves protect the arms against:
   - A. Ultraviolet radiation.
   - B. Infrared radiation.
   - C. Welding splatter.
   - D. All of the above.
   - E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
   - A. Current polarity
   - B. Arc length
   - C. Length of the electrode
   - D. All of the above are variables in the process.
   - E. None of the above.

6. Acceptable welding footwear includes:
   A. Roman sandals.
   B. Tennis shoes.
   C. Canvas boots.
   D. All of the above.
   E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   A. Excess convexity.
   B. Overlap.
   C. Porosity.
   D. All of the above.
   E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   A. DC-.
   B. DC+.
   C. AC.
   D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
    - A. On.
    - B. Off.
    - C. On or off, depending on the repair.
    - D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
    - A. On rubber work mats.
    - B. Elevated off the floor.
    - C. Grounded.
    - D. All of the above.
    - E. None of the above.

14. Which of the following electrodes is NOT in the low-hydrogen family?
    - A. E7015
    - B. E7016
    - C. E7018
    - D. All of the above are low-hydrogen electrodes.
    - E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
    - A. Technician A only.
    - B. Technician B only.
    - C. Both Technicians A and B.
    - D. Neither Technician A nor B.

16. Fire inspections should be continued for at least __________ after completion of the welding.
    - A. Fifteen minutes
    - B. Thirty minutes
    - C. One hour
    - D. Two hours

17. The welding area should be:
    - A. Isolated from other workers by shields.
    - B. At least 35 feet from combustible materials.
    - C. Dry.
    - D. All of the above.
    - E. None of the above.

18. Seam welds generally require _____________ oscillation.

A. No
B. Very little
C. Moderate
D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?

A. Technician A only.
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:

A. Do not weld
B. Take frequent breaks to inspect the area for fires
C. Station a fire watcher near the combustible materials
D. Any of the above is acceptable
E. None of the above

21. E7018 electrodes should never be used with

A. DC-
B. DC+
C. AC
D. There is no such electrode

22. Areas to be welded should be thoroughly cleaned

A. Prior to fit-up
B. By brushing, sanding, or grinding
C. With safe solvents
D. All of the above, as necessary
E. None of the above

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?

A. Technician A only
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

24. Low-hydrogen electrodes may be stored
   A. In sealed cans or heated rod ovens
   B. Under water
   C. In petroleum jelly
   D. Any of the above
   E. None of the above

25. As the material being welded increases in thickness, the travel speed of the weld must
   A. Increase
   B. Decrease
   C. Either A or B, depending on the desired effect
   D. Stay the same
   E. None of the above

WLD-L9

Post Clean Weld

Self-Assessment No. 3 Answer Key

1.	b	16.	b
2.	a	17.	d
3.	a	18.	b
4.	d	19.	c
5.	c	20.	c
6.	e	21.	a
7.	e	22.	d
8.	c	23.	b
9.	b	24.	a
10.	c	25.	b
11.	c		
12.	b		
13.	c		
14.	d		
15.	a		

WELDER SERIES

MASTER Technical Module No. WLD-L10

SUBJECT: **WELDING TECHNICIAN** **TIME: 6 HOURS**

- **DUTY:** **SHIELDED METAL ARC WELDING (SMAW) (BASIC)**
- **TASK:** Post Finish Weld

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify requirements of the welding procedure specification.

B. Use wire brushes, etc., to meet the requirements of the welding procedure specification.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written examinations on post finish process
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video materials
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Shielded Metal Arc Welding machine
Welding shop tools
Selection of base metals for welding and cutting
Selection of filler metals and electrode wire
MASTER Handout No. 1 (WLD-L10-HO1)
MASTER Handout No. 2 (WLD-L10-HO2)
MASTER Handout No. 3 (WLD-L10-HO3)
MASTER Handout No. 4 (WLD-L10-HO4)
MASTER Handout No. 5 (WLD-L10-HO5)
MASTER Handout No. 6 (WLD-L10-HO6)
MASTER Laboratory Aid (WLD-L10-LA)
MASTER Laboratory Worksheet (WLD-L10-LW)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition

Reading Welding Blueprints & Symbols, Stinchcomb, Craig, New Jersey: Prentice-Hall, Inc., Latest Edition

Certification Manual For Welding Inspector, American Welding Society, Miami, FL, (ISBN 0-87171-421-3) Latest Edition

Welding Qualifications, Practical Guide to ASME Section IX, Houle, Michael J., *CASTI* Publishing, Inc., Canada, (ISBN 0-9696428-5-7), Latest Edition

The Procedure Handbook of Arc Welding; The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students will complete the following modules:

WLD-L1	"Preheat Joint"
WLD-L2	"Initiate Welding Process"
WLD-L3	"Perform Weld Sequence"
WLD-L4	"Control Weld Technique"
WLD-L5	"Maintain Preheat and Perform Interpass"
WLD-L6	"Use the Carbon Arc Process to Cut and Gouge Weld Materials"
WLD-L7	"Apply Welders Identification"
WLD-L8	"Control Post-Weld Temperature According to Procedures"
WLD-L9	"Post Clean Weld"

INTRODUCTION:

The Course Introduction will Include:

- The importance of post finishing the job after welding
- Quality procedures are reflected in the final product

PRESENTATION OUTLINE:

Instructor Topics:

A. "Post finishing" is defined as the process steps to be followed after welding.

B. These steps may be further testing, cleaning, polishing or metal preparation (hardening, etc.) prior to painting or galvanizing the finished product.

C. Many metal products are purchased by customers who require not only a perfect welding product, a high quality finish or appearance that is important to the end user.

D. Applications of chemical cleaning, sanding, and metal preparation for finishing.

E. Importance of the weld to strength function, fit and finish.

Student Activities:

A. Tour a production facility and observe manufacturing processes beginning with materials selection, preparation, welding, weld inspection, and ending with the finishing of the metal product.

B. Assessing the importance of the weld quality to strength, function, fit, and finish.

PRACTICAL APPLICATION:

The student will gain an appreciation for his work as it relates to strength, function, fit, and finish. Quality demands that the product meet or exceed all specifications.

EVALUATION AND/OR VERIFICATION:

Written examinations will be given in this module to determine student progress. Practical work will be evaluated by the student and the instructor, and the "customer."

SUMMARY:

Removal of scale, slag, oxides at various steps of the welding process; use of quality welding techniques, and final surface preparation leads to a product that also has high appearance value and surface durability.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-L11) dealing with passing a performance qualification test using SMAW on carbon steel pipe in the 6G position.

WLD-L10-HO1
Post Finish Weld
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify requirements of the welding procedure specification.

B. Use wire brushes, etc., to meet the requirements of the welding procedure specification.

MODULE OUTLINE:

Instructor Topics:

A. "Post finishing" is defined as the process steps to be followed after welding.

B. These steps may be further testing, cleaning, polishing or metal preparation (hardening, etc.) prior to painting or galvanizing the finished product.

C. Many metal products are purchased by customers who require not only a perfect welding product, a high quality finish or appearance that is important to the end user.

D. Applications of chemical cleaning, sanding, and metal preparation for finishing.

E. Importance of the weld to strength function, fit and finish.

Student Activities:

A. Tour a production facility and observe manufacturing processes beginning with materials selection, preparation, welding, weld inspection, and ending with the finishing of the metal product.

B. Assessing the importance of the weld quality to strength, function, fit, and finish

WLD-L10-HO2
Post Finish Weld
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
  A. Hardening for utility
  B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  A. Brine (water and sodium chloride or sodium hydroxide)
  B. Water
  C. Fused (liquid) salts
  D. Molten lead
  E. Soluble oil and water
  F. Oil
  G. Air
IV. Estimate Metal Heat Temperature by Color
  A. Use of temper color chart for tempering
  B. *Chicken Wire* markings warn of overheating.

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L10-HO3
Post Finish Weld
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
  A. Imprecise method, good for rough estimates only
  B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
  A. High-carbon steels show more spark bursts than do low-carbon steels.
  B. Non-ferrous metals
    1. Aluminum
    2. Magnesium
    3. Brass
    4. Bronze
    5. Nickel
    6. Tin
    7. Others
III. Perform Rockwell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
  A. Ferrous metals
  B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L10-HO4
Post Finish Weld
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

   c. Verbally warn others of intent to arc weld
   d. Strike an arc
   e. Weld with stringer bead technique
   f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
   a. Make manual free hand straight line cuts
   b. Cut manually straight lines using cutting jib
   c. Bevel plate with manual oxy-fuel equipment
   d. Manually cut blind holes in thick material
   e. Manually cut sheet metal with minimal distortion

WLD-L10-HO5
Post Finish Weld
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

- g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
- h. Chip slag and wire brush weld
- i. Grind any lack of fusion and/or high spots
- j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
- k. Visually inspect weld on the root and face sides to ASME Section 9
- l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
    - a. Measure the pipe
    - b. Mark the cut line with a wrap around and soapstone
    - c. Cut the bevel using oxy-fuel gas equipment
    - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    - e. Use the grinder to add a root face of from 3/32" to 1/8"
    - f. Tack the single V groove pipe joint with a 3/32" root opening
    - g. Weld pipe joint
    - h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    - i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    - j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    - k. Visually inspect weld on the root and face sides to ASME Section 9
    - l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
    - a. Measure the pipe
    - b. Mark the cut line with a wrap around and soapstone
    - c. Cut the bevel using oxy-fuel gas equipment
    - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    - e. Use the grinder to add a root face of from 3/32" to 1/8"
    - f. Tack the single V groove pipe joint with a 3/32" root opening
    - g. Roll weld pipe
    - h. Place pipe coupon on workbench in the 1G roll welding position.
    - i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
    - j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

- k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
- l. Visually inspect weld on the root and face sides to ASME Section 9
- m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
    - a. Measure the pipe and
    - b. Mark the cut line with a wrap around and soapstone
    - c. Cut the bevel using oxy-fuel gas equipment
    - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    - e. Use the grinder to add a root face of from 3/32" to 1/8"
    - f. Weld pipe
    - g. Tack the single V groove pipe joint with a 3/32" root opening
    - h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
    - i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    - j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    - k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    - l. Visually inspect weld on the root and face sides to ASME Section 9
    - m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
7. Produce SMAW Pipe - 6G Position
    - a. Measure the pipe
    - b. Mark the cut line with a wrap around and soapstone
    - c. Cut the bevel using oxy-fuel gas equipment
    - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    - e. Use the grinder to add a root face of from 3/32" to 1/8"
    - f. Tack the single V groove pipe joint with a 3/32" root opening
    - g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
    - h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    - i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    - j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    - k. Visually inspect weld on the root and face sides to ASME Section 9

- l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    - a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    - b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    - c. Set welding condition to weld open roots
    - d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    - e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    - f. Weld balance of the V groove with this procedure
    - g. Visual inspection is made and evaluated by ASME Section 9
    - h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    - a. Identify process
    - b. Name joint design
    - c. List base material
    - d. Give dimensions for root treatment
    - e. Name electrode size and type being used
    - f. List filler material (if required), classification and specification
    - g. Identify shielding gas - type and mixture
    - h. List pre and post heat and interpass temperature
    - i. Describe initial and interpass cleaning
    - j. Describe technique which is used
    - k. Produce single or multiple pass weld
    - l. Choose current type
    - m. Set current amperage
    - n. Set current polarity
    - o. Set voltage

WLD-L10-HO6
Post Finish Weld
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
   - a. Produce end preparations with oxy-fuel cutting
   - b. Produce end preparations with plasma cutting
   - c. Produce end preparations with mechanical cutting
   - d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
   - a. Cut and single bevel pipe to 37 1/2°
   - b. Ground bevel face and touch up to within tolerances
   - c. Check that pipe ends are square within given tolerances
   - d. Prepare root face within given tolerances
   - e. Align pipe to within given tolerances
   - f. Set root opening to within given tolerances
   - g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
   - a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   - b. Weld remainder of pipe in the 1G roll welding position with E6010
   - c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   - a. Weld using 1/8" E6010
   - b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   - c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   - d. Weld root pass to ASME Section 9 requirements
   - e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
   - a. Fit and tack weld pipe to within tolerances
   - b. Place pipe in the 5G position
   - c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
   - d. Grind the finished root pass to remove high spots and any slag at weld toes

    e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements
6. Pass Guided Bond Tests Per ASME Section 9
    a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
    b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
    c. Weld remainder of pipe in 1G position using E7018
    d. Perform low hydrogen starts and stops
    e. Weld using stringer bead technique
    f. Weld using weave technique
    g. Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
    a. Use 1/8" E6010
    b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
    c. Fit together two pipe ends to a single V edge preparation within given tolerances
    c. Weld root pass to ASME Section 9 requirements
    d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
    e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
    a. Set up GMAW equipment
    b. Adjust wire feeder drive system
    c. Adjust shielding gas system and flow rate
    d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
    e. Set welding condition for short circuit transfer - Wire Feed Speed
    f. Set welding condition for short circuit transfer - Voltage
    g. Set welding condition for short circuit transfer - Tip to work Distance
    h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
    a. Bevel pipe ends
    b. Touch up bevel face with grinder
    c. Fit and tack backing ring to one pipe end
    d. Fit other pipe over backing ring
    e. Adjust gap and tack in place
    f. Adjust shielding gas flow
    g. Adjust wire feed system
    h. Adjust power source to procedure specification
    i. Set wire feed speed to procedure specification
    j. Adjust voltage to procedure specification
    k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L10-LA
Post Finish Weld
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.

B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.

C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.

D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.

B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.

C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.

D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.

E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.

F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.

G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.

H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.

B. Cover all skin surfaces. Keep shirt sleeves rolled down.

C. Wear cuffless pants to eliminate spatter traps.

D. Wear leather boots. Pant legs should cover boot tops.

E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.

F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.

G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.

H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.

I. Wear a 100% cotton cap to protect the head from sparks or spatter.

J. Wear long gauntlet leather gloves.

K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.

L. Protect nearby workers from exposure to the welding arc by putting up shields.

M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.

B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current

DC+(DCRP) Direct Current Reverse Polarity

DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. **Prepare Weldment for Welding**

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

        (1) Product design
        (2) Material thickness
        (3) Design strength requirements
        (4) Welding process employed
    b. SMAW weld joint configuration may be a:
        (1) Lap joint
        (2) Tee joint
        (3) Corner joint
        (4) Edge joint
        (5) Butt joint with backing
        (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
- a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
- b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. **Complete Welding Operation**

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
- a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
- b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
- c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

Name ______________________________ Date ____________________________

WLD-L10
Post Finish Weld
Self-Assessment No. 1

Circle the best answer.

1. What is the approximate temperature required for stress relief annealing of low-carbon steels?
   - A. 950°
   - B. 1000°
   - C. 1950°
   - D. 1700°
   - E. None of the above

2. What crystalline processes result from stress relief annealing?
   - A. All grains reform into softer grains
   - B. Distorted grains reform into softer grains
   - C. Ferrite grains reform into softer grains while pearlite grains are basically unaffected
   - D. Pearlite grains reform into softer grains while ferrite grains are basically unaffected
   - E. None of the above

3. Which of the following is NOT a cause of quenching cracks?
   - A. Improper quenching medium
   - B. Overheating during the austenitizing cycle
   - C. Improper quenching angle
   - D. All of the above are causes of quenching cracks
   - E. None of the above answers is correct

4. Which of the following is NOT a characteristic of typical quench cracks?
   - A. The fracture tends to run from the surface toward the center in a smooth curve
   - B. Untempered quench cracks will not show any decarburization
   - C. Tempered fracture surfaces will show a fine crystalline structure
   - D. All of the above are characteristic of quench cracks
   - E. None of the above

5. During tempering by color, which of the following colors represents the highest temperature?
   A. Gold
   B. Purple
   C. Dark Straw
   D. Pale Blue
   E. Violet

6. During tempering by color, which of the following colors represents the lowest temperature?
   A. Gold
   B. Purple
   C. Dark Straw
   D. Pale Blue
   E. Violet

7. What is meant by *step quenching*?
   A. The workpiece is first quenched in a slow medium (e.g., air) then in a fast medium (e.g., water)
   B. The workpiece is first quenched in a fast medium (e.g., water) then in a slow medium (e.g., air)
   C. The weaker parts of the workpiece are quenched separately from the main body of the workpiece
   D. The workpiece is lowered into the quenching medium in steps so that different parts of the workpiece attain different hardnesses
   E. None of the above

8. What is the simplest thing that the technician can do to minimize the vapor-blanket stage of liquid quenching?
   A. Agitate the workpiece or the medium
   B. Heat the quenching medium to just below its boiling point
   C. Quickly insert the workpiece into the medium
   D. Slowly insert the workpiece into the medium
   E. None of the above

9. Liquid carburizing, as used in case hardening, utilizes __________ and is therefore extremely dangerous.
   A. Sodium chloride
   B. Calcium carbonate
   C. Cyanide salts
   D. Ammonia
   E. None of the above

10. Workpieces which have been cut with an oxyacetylene torch often display edge hardness because

A. The torch was starved for oxygen
B. The workpiece was cut at too low a temperature
C. The wrong type of cutting torch was used
D. Oxyacetylene torches always leave hardened edges
E. None of the above

WLD-L10
Post Finish Weld
Self-Assessment No. 1 Answer Key

1.	a
2.	c
3.	d
4.	a
5.	c
6.	d
7.	b
8.	a
9.	c
10.	a

Name ______________________________ Date ____________________

WLD-L10
Post Finish Weld
Self-Assessment No. 2

Circle the best answer.

1. The *hardness* of a metal is its ability to resist:
   - A. Permanent deformation.
   - B. Oxidation.
   - C. Chemical reaction.
   - D. All of the above answers are forms of hardness.
   - E. None of the above.

2. Rockwell testing machines test the sample metal's resistance to:
   - A. Abrasion.
   - B. Penetration.
   - C. Elastic deformation.
   - D. Electricity.
   - E. None of the above.

3. Materials such as nitrided steel and hard cast irons generally have Rockwell hardness numbers in excess of
   - A. B-50.
   - B. B-75.
   - C. B- 100.
   - D. B-150.
   - E. None of the above.

4. During the file test, if the file will mark the metal but not cut into it, then the metal should be treated as:
   - A. High-alloy steel.
   - B. Mild steel.
   - C. Hardened tool steel.
   - D. Medium-carbon steel.
   - E. None of the above.

5. Probably the best use of the spark test is to:
   - A. Determine the alloy content of the sample.
   - B. Identify cast iron.
   - C. Compare the sample to a known piece.
   - D. All of the above answers are valid.
   - E. None of the above.

6. Tool steel has a Rockwell hardness of __________, while hardened tool steel has hardness number of __________.
A. C-42 - C-64
B. C-42 - B-65
C. C-64 - C-42
D. B-65 - C-42
E. None of the above.

7. Which of the following surfaces should be avoided when hardness testing?
A. Curved
B. Rough
C. Decarburized
D. All of the above surfaces should be modified before testing the sample's hardness.
E. None of the above.

8 For hardness testing, the minimum recommended clearance from the edge is:
A. 1/2"
B. 1/4"
C. 1/8"
D. 1/16"
E. None of the above.

9 If a Rockwell tester is in daily use, it should be calibrated:
A. Annually.
B. Monthly.
C. Weekly.
D. Daily.
E. Never.

10. Technician A says that, for large samples, multiple hardness test should be made and their results averaged. Technician B says that many materials vary in hardness over the length of the sample. Who is correct?
A. Technician A only
B. Technician B only
C. Both technicians are correct.
D. Neither technician is correct.

WLD-L10
Post Finish Weld
Self-Assessment No. 2 Answer Key

1.	a
2.	b
3.	c
4.	c
5.	c
6.	e
7.	d
8.	c
9.	d
10.	d

Name: ______________________________ Date: ___________________________

WLD-L10
Post Finish Weld
Self-Assessment No. 3

Choose the best answer.

1. The size of the bead is __________ proportional to the speed of travel.
   - A. Directly
   - B. Inversely
   - C. Not
   - D. None of the above

2. The eye shield of the welding helmet should be:
   - A. Just light enough to clearly see the arc.
   - B. Too dark to clearly see the arc.
   - C. A minimum of #5.
   - D. None of the above.

3. Welding in confined spaces may require:
   - A. Air supplied hoods or hose masks.
   - B. Frequent breaks.
   - C. Large, high-displacement fans.
   - D. All of the above.
   - E. None of the above.

4. Long sleeves protect the arms against:
   - A. Ultraviolet radiation.
   - B. Infrared radiation.
   - C. Welding splatter.
   - D. All of the above.
   - E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
   - A. Current polarity
   - B. Arc length
   - C. Length of the electrode
   - D. All of the above are variables in the process.
   - E. None of the above.

6. Acceptable welding footwear includes:
   A. Roman sandals.
   B. Tennis shoes.
   C. Canvas boots.
   D. All of the above.
   E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   A. Excess convexity.
   B. Overlap.
   C. Porosity.
   D. All of the above.
   E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   A. DC-.
   B. DC+.
   C. AC.
   D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
  - A. On.
  - B. Off.
  - C. On or off, depending on the repair.
  - D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
  - A. On rubber work mats.
  - B. Elevated off the floor.
  - C. Grounded.
  - D. All of the above.
  - E. None of the above.

14. Which of the following electrodes is NOT in the low-hydrogen family?
  - A. E7015
  - B. E7016
  - C. E7018
  - D. All of the above are low-hydrogen electrodes.
  - E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
  - A. Technician A only.
  - B. Technician B only.
  - C. Both Technicians A and B.
  - D. Neither Technician A nor B.

16. Fire inspections should be continued for at least ___________ after completion of the welding.
  - A. Fifteen minutes
  - B. Thirty minutes
  - C. One hour
  - D. Two hours

17. The welding area should be:
  - A. Isolated from other workers by shields.
  - B. At least 35 feet from combustible materials.
  - C. Dry.
  - D. All of the above.
  - E. None of the above.

18. Seam welds generally require _____________ oscillation.

A. No
B. Very little
C. Moderate
D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?

A. Technician A only.
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:

A. Do not weld
B. Take frequent breaks to inspect the area for fires
C. Station a fire watcher near the combustible materials
D. Any of the above is acceptable
E. None of the above

21. E7018 electrodes should never be used with

A. DC-
B. DC+
C. AC
D. There is no such electrode

22. Areas to be welded should be thoroughly cleaned

A. Prior to fit-up
B. By brushing, sanding, or grinding
C. With safe solvents
D. All of the above, as necessary
E. None of the above

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?

A. Technician A only
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

24. Low-hydrogen electrodes may be stored
   A. In sealed cans or heated rod ovens
   B. Under water
   C. In petroleum jelly
   D. Any of the above
   E. None of the above

25. As the material being welded increases in thickness, the travel speed of the weld must
   A. Increase
   B. Decrease
   C. Either A or B, depending on the desired effect
   D. Stay the same
   E. None of the above

WLD-L10
Post Finish Weld
Self-Assessment No. 3 Answer Key

1. b
2. a
3. a
4. d
5. c
6. e
7. e
8. c
9. b
10. c
11. c
12. b
13. c
14. d
15. a
16. b
17. d
18. b
19. c
20. c
21. a
22. d
23. b
24. a
25. b

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and [illegible] welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

[illegible]

Duty L2

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES
MASTER Technical Module No. WLD-L11

SUBJECT: **WELDING TECHNICIAN** **TIME: 15 HOURS**

- **DUTY:** **SHIELDED METAL ARC WELDING (SMAW) (ADVANCED)**
- **TASK:** Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe in the 6G Position

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Set-up work area and equipment;
B. Set-up work piece; and,
C. Weld test piece according to specifications.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on SMAW with carbon steel pipe
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video materials
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Shielded Metal Arc Welding machine
Welding shop tools
Selection of base metals for welding and cutting
Selection of filler metals and electrode wire
MASTER Handout No. 1 (WLD-L11-HO1)
MASTER Handout No. 2 (WLD-L11-HO2)
MASTER Handout No. 3 (WLD-L11-HO3)
MASTER Handout No. 4 (WLD-L11-HO4)
MASTER Handout No. 5 (WLD-L11-HO5)
MASTER Handout No. 6 (WLD-L11-HO6)
MASTER Laboratory Aid (WLD-L11-LA)
MASTER Laboratory Worksheet (WLD-L11-LW)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition

Reading Welding Blueprints & Symbols, Stinchcomb, Craig, New Jersey: Prentice-Hall, Inc., Latest Edition

Certification Manual For Welding Inspector, American Welding Society, Miami, FL, (ISBN 0-87171-421-3) Latest Edition

Welding Qualifications, Practical Guide to ASME Section IX, Houle, Michael J., *CASTI* Publishing, Inc., Canada, (ISBN 0-9696428-5-7), Latest Edition

The Procedure Handbook of Arc Welding; The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students will complete the following modules:

WLD-L1	"Preheat Joint"
WLD-L2	"Initiate Welding Process"
WLD-L3	"Perform Weld Sequence"
WLD-L4	"Control Weld Technique"
WLD-L5	"Maintain Preheat and Perform Interpass"
WLD-L6	"Use the Carbon Arc Process to Cut and Gouge Weld Materials"
WLD-L7	"Apply Welders Identification"
WLD-L8	"Control Post-Weld Temperature According to Procedures"
WLD-L9	"Post Clean Weld"
WLD-L10	"Post Finish Weld"

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need for pipe welding in welding occupations
- A class demonstration of effective pipe welding techniques
- A discussion on training activities resulting in an increase of skill and knowledge leading to certification.

PRESENTATION OUTLINE:

Instructor Topics:

A. Emphasizes the advantages and disadvantages involved with the use of SMAW equipment
B. Present joint design, concepts, and welding terms for pipe welding
C. Interpret drawings and blueprints for pipe welding
D. Demonstrate the proper application of welding skills for pipe welding
E. Demonstrate adequate preparation of welding surfaces
F. Increase student skill level to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Demonstrate SMAW in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using SMAW on various metals
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match SMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in multiple positions
C. Use welding technique suitable for pipe welding
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience in this area with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

Examinations will be given in this module to determine student progress. The student will critique his work and the instructor will evaluate quality of weld.

SUMMARY:

Emphasis is placed on skill necessary to pass a SMAW performance qualification test for pipe welding.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-L12) dealing with passing a performance qualification test using SMAW on stainless steel pipe in the 6G position.

WLD-L11-HO1

Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Set-up work area and equipment;
B. Set-up work piece; and,
C. Weld test piece according to specifications.

MODULE OUTLINE:

Instructor Topics:

A. Emphasizes the advantages and disadvantages involved with the use of SMAW equipment
B. Present joint design, concepts, and welding terms for pipe welding
C. Interpret drawings and blueprints for pipe welding
D. Demonstrate the proper application of welding skills for pipe welding
E. Demonstrate adequate preparation of welding surfaces
F. Increase student skill level to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Demonstrate SMAW in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using SMAW on various metals
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match SMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in multiple positions
C. Use welding technique suitable for pipe welding
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-L11-HO2
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
  A. Hardening for utility
  B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  A. Brine (water and sodium chloride or sodium hydroxide)
  B. Water
  C. Fused (liquid) salts
  D. Molten lead
  E. Soluble oil and water
  F. Oil
  G. Air
IV. Estimate Metal Heat Temperature by Color
  A. Use of temper color chart for tempering
  B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
    A. Increased machinability
    B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
    A. Protective Gear against . . .
        1. Heat
        2. Fumes
        3. Concussion
    B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
    A. Brittleness
    B. Distortion
    C. Discoloration (sometimes unimportant)
    D. Inadvertent heat treating

WLD-L11-HO3

Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position

Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;

b. Use other tests to identify metals; and,

c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
   A. Imprecise method, good for rough estimates only
   B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
   A. High-carbon steels show more spark bursts than do low-carbon steels.
   B. Non-ferrous metals
      1. Aluminum
      2. Magnesium
      3. Brass
      4. Bronze
      5. Nickel
      6. Tin
      7. Others
III. Perform Rockwell Hardness Tests
   A. Ferrous metals
   B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
   A. Ferrous metals
   B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
   A. Ferrous metals
   B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L11-HO4
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly

    - b. Operate welding helmet
    - c. Verbally warn others of intent to arc weld
    - d. Strike an arc
    - e. Weld with stringer bead technique
    - f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
    - a. Maintain required weld quality
    - b. Maintain proper weld width uniformly
    - c. Maintain proper travel speed
    - d. Match correct oscillation for various electrodes
    - e. Match applications to weave techniques, as they apply
    - f. List the advantages and disadvantages of weave techniques
    - g. List the advantages and disadvantages of stringer techniques
    - h. Perform weld using weave technique
    - i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
    - a. Weld a dam to outline area being welded for each layer
    - b. Apply each layer neatly, straight and with good fusion throughout
    - c. Chip slag after each pass
    - d. Weld passes which over lap to crown of last weld bead
    - e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
    - a. Follow manufacturer's recommended practice
    - b. Inspect equipment and work area for safety
    - c. Assemble oxy-fuel equipment
    - d. Open fuel gas cylinder ½ turn
    - e. Open oxygen as cylinder all the way
    - f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
    - g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    - a. Make manual free hand straight line cuts
    - b. Cut manually straight lines using cutting jib
    - c. Bevel plate with manual oxy-fuel equipment
    - d. Manually cut blind holes in thick material
    - e. Manually cut sheet metal with minimal distortion

WLD-L11-HO5
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position

Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    - a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    - b. Use grinder to remove oxide larger and smooth plate
    - c. Use grinder to create root face of 3/32" to 1/8"
    - d. Tack single V groove joint with 3/32" root opening
    - e. Place joint in the 1G position
    - f. Place joint in 2G position once task is mastered
    - g. Place joint in 3G position once task is mastered
    - h. Place joint in 4G position once task is mastered
    - i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    - j. Weld chipped side slag and the root bead is wire brushed
    - k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    - l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    - a. Inspect area for safety
    - b. Place plate flat on welding table
    - c. Place 3" pipe vertically on top of plate and tacked in place
    - d. Leave weld coupon in the 2F fixed position
    - e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    - f. Visually inspect weld to AWS D1.1
    - g. Fill pipe with water for 24 hours
    - h. Check for leak
3. Produce SMAW Pipe - 5G Position
    - a. Measure the pipe
    - b. Mark the cut line with a wrap around and soapstone
    - c. Cut the bevel using oxy-fuel gas equipment
    - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    - e. Use the grinder to add a root face of from 3/32" to 1/8"
    - f. Tack the single V groove pipe joint with a 3/32" root opening

    g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    h. Chip slag and wire brush weld
    i. Grind any lack of fusion and/or high spots
    j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Weld pipe joint
    h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Roll weld pipe
    h. Place pipe coupon on workbench in the 1G roll welding position.
    i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9

   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
   a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
   b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
   c. Set welding condition to weld open roots
   d. Tack pipe nipples together to form a V groove with a 1/8" root opening
   e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
   f. Weld balance of the V groove with this procedure
   g. Visual inspection is made and evaluated by ASME Section 9
   h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
   a. Identify process
   b. Name joint design
   c. List base material
   d. Give dimensions for root treatment
   e. Name electrode size and type being used
   f. List filler material (if required), classification and specification
   g. Identify shielding gas - type and mixture
   h. List pre and post heat and interpass temperature
   i. Describe initial and interpass cleaning
   j. Describe technique which is used
   k. Produce single or multiple pass weld
   l. Choose current type
   m. Set current amperage
   n. Set current polarity
   o. Set voltage

WLD-L11-HO6
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    - a. Produce end preparations with oxy-fuel cutting
    - b. Produce end preparations with plasma cutting
    - c. Produce end preparations with mechanical cutting
    - d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    - a. Cut and single bevel pipe to 37 1/2°
    - b. Ground bevel face and touch up to within tolerances
    - c. Check that pipe ends are square within given tolerances
    - d. Prepare root face within given tolerances
    - e. Align pipe to within given tolerances
    - f. Set root opening to within given tolerances
    - g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    - a Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    - b Weld remainder of pipe in the 1G roll welding position with E6010
    - c Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    - a Weld using 1/8" E6010
    - b Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    - c Fit together the two pipe ends to a single V edge preparation with given tolerances
    - d Weld root pass to ASME Section 9 requirements
    - e Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    - a. Fit and tack weld pipe to within tolerances
    - b. Place pipe in the 5G position
    - c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements

d. Grind the finished root pass to remove high spots and any slag at weld toes

e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9

a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions

b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.

c. Weld remainder of pipe in 1G position using E7018

d. Perform low hydrogen starts and stops

e. Weld using stringer bead technique

f. Weld using weave technique

g Chip slag wire brush and grind as necessary to assure clean weld deposits

7. Weld Open Root Pipe - 2G Position

a. Use 1/8" E6010

b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°

c. Fit together two pipe ends to a single V edge preparation within given tolerances

c. Weld root pass to ASME Section 9 requirements

d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit

e Weld remainder of the groove using E7018 with the stringer bead technique

8. Weld Pipe Open Root Passes All Positions Using GMAW

a. Set up GMAW equipment

b. Adjust wire feeder drive system

c. Adjust shielding gas system and flow rate

d. Adjust GMAW gun to allow proper tip to work distance and gas coverage

e. Set welding condition for short circuit transfer - Wire Feed Speed

f. Set welding condition for short circuit transfer - Voltage

g. Set welding condition for short circuit transfer - Tip to work Distance

h. Weld root using a string bead technique

9. Weld Pipe With Backing Using FCAW-G

a. Bevel pipe ends

b. Touch up bevel face with grinder

c. Fit and tack backing ring to one pipe end

d. Fit other pipe over backing ring

e. Adjust gap and tack in place

f. Adjust shielding gas flow

g. Adjust wire feed system

h. Adjust power source to procedure specification

i. Set wire feed speed to procedure specification

j. Adjust voltage to procedure specification
k. Adjust inductance to procedure specification
l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L11-LA
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: **Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.**

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: **Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.**

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.
C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.
D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.
E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.
F. Do not weld on materials having either a coating or internal structure that is combustible.
G. Place hot scrap and slag in non-combustible containers.
H. Ensure that fire extinguishers are available nearby.
I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.
J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

Worksheet:

1. **Choose Proper Power Source**

   Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

   Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

   Step 1. Choose the proper electrode for the job.

   NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

   The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

   Step 2. Store the electrodes properly.

   a. Low-hydrogen electrodes:
      (1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.
      (2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.
      (3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current

DC+(DCRP) Direct Current Reverse Polarity

DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.
  a. Weld joint configuration will depend upon:
    (1) Product design
    (2) Material thickness
    (3) Design strength requirements
    (4) Welding process employed
  b. SMAW weld joint configuration may be a:
    (1) Lap joint
    (2) Tee joint
    (3) Corner joint
    (4) Edge joint
    (5) Butt joint with backing
    (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
  a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
  b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. **Complete Welding Operation**

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
  a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
  b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
  c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely

related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.
b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. Troubleshoot Welding Problems

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

- a. Type of electrode
- b. Diameter of electrode
- c. Type of current (AC or DC)
- d. Current polarity (DC+ or DC-)
- e. Current setting
- f. Arc length
- g. Travel speed
- h. Electrode angle
- i. Electromagnetic arc blow
- j. Electrode manipulation technique (drag, whip)
- k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

- a. Type of base metal
- b. Thickness of base metal
- c. Surface condition of base metal (clean, rusty, or painted)
- d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

Name ______________________________ Date ____________________________

WLD-L11
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Self-Assessment No. 1

Circle the best answer.

1. What is the approximate temperature required for stress relief annealing of low-carbon steels?
   - A. 950°
   - B. 1000°
   - C. 1950°
   - D. 1700°
   - E. None of the above

2. What crystalline processes result from stress relief annealing?
   - A. All grains reform into softer grains
   - B. Distorted grains reform into softer grains
   - C. Ferrite grains reform into softer grains while pearlite grains are basically unaffected
   - D. Pearlite grains reform into softer grains while ferrite grains are basically unaffected
   - E. None of the above

3. Which of the following is NOT a cause of quenching cracks?
   - A. Improper quenching medium
   - B. Overheating during the austenitizing cycle
   - C. Improper quenching angle
   - D. All of the above are causes of quenching cracks
   - E. None of the above answers is correct

4. Which of the following is NOT a characteristic of typical quench cracks?
   - A. The fracture tends to run from the surface toward the center in a smooth curve
   - B. Untempered quench cracks will not show any decarburization
   - C. Tempered fracture surfaces will show a fine crystalline structure
   - D. All of the above are characteristic of quench cracks
   - E. None of the above

5. During tempering by color, which of the following colors represents the highest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

6. During tempering by color, which of the following colors represents the lowest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

7. What is meant by *step quenching*?
   - A. The workpiece is first quenched in a slow medium (e.g., air) then in a fast medium (e.g., water)
   - B. The workpiece is first quenched in a fast medium (e.g., water) then in a slow medium (e.g., air)
   - C. The weaker parts of the workpiece are quenched separately from the main body of the workpiece
   - D. The workpiece is lowered into the quenching medium in steps so that different parts of the workpiece attain different hardnesses
   - E. None of the above

8. What is the simplest thing that the technician can do to minimize the vapor-blanket stage of liquid quenching?
   - A. Agitate the workpiece or the medium
   - B. Heat the quenching medium to just below its boiling point
   - C. Quickly insert the workpiece into the medium
   - D. Slowly insert the workpiece into the medium
   - E. None of the above

9. Liquid carburizing, as used in case hardening, utilizes __________ and is therefore extremely dangerous.
   - A. Sodium chloride
   - B. Calcium carbonate
   - C. Cyanide salts
   - D. Ammonia
   - E. None of the above

10. Workpieces which have been cut with an oxyacetylene torch often display edge hardness because

A. The torch was starved for oxygen
B. The workpiece was cut at too low a temperature
C. The wrong type of cutting torch was used
D. Oxyacetylene torches always leave hardened edges
E. None of the above

WLD-L11

Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position

Self-Assessment No. 1 Answer Key

1. a
2. c
3. d
4. a
5. c
6. d
7. b
8. a
9. c
10. a

Name ______________________________ Date ____________________

WLD-L11

Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position

Self-Assessment No. 2

Circle the best answer.

1. The *hardness* of a metal is its ability to resist:
   - A. Permanent deformation.
   - B. Oxidation.
   - C. Chemical reaction.
   - D. All of the above answers are forms of hardness.
   - E. None of the above.

2. Rockwell testing machines test the sample metal's resistance to:
   - A. Abrasion.
   - B. Penetration.
   - C. Elastic deformation.
   - D. Electricity.
   - E. None of the above.

3. Materials such as nitrided steel and hard cast irons generally have Rockwell hardness numbers in excess of
   - A. B-50.
   - B. B-75.
   - C. B- 100.
   - D. B-150.
   - E. None of the above.

4. During the file test, if the file will mark the metal but not cut into it, then the metal should be treated as:
   - A. High-alloy steel.
   - B. Mild steel.
   - C. Hardened tool steel.
   - D. Medium-carbon steel.
   - E. None of the above.

5. Probably the best use of the spark test is to:
   - A. Determine the alloy content of the sample.
   - B. Identify cast iron.
   - C. Compare the sample to a known piece.
   - D. All of the above answers are valid.
   - E. None of the above.

6. Tool steel has a Rockwell hardness of __________, while hardened tool steel has hardness number of __________.
   A. C-42 - C-64
   B. C-42 - B-65
   C. C-64 - C-42
   D. B-65 - C-42
   E. None of the above.

7. Which of the following surfaces should be avoided when hardness testing?
   A. Curved
   B. Rough
   C. Decarburized
   D. All of the above surfaces should be modified before testing the sample's hardness.
   E. None of the above.

8. For hardness testing, the minimum recommended clearance from the edge is:
   A. 1/2"
   B. 1/4"
   C. 1/8"
   D. 1/16"
   E. None of the above.

9. If a Rockwell tester is in daily use, it should be calibrated:
   A. Annually.
   B. Monthly.
   C. Weekly.
   D. Daily.
   E. Never.

10. Technician A says that, for large samples, multiple hardness test should be made and their results averaged. Technician B says that many materials vary in hardness over the length of the sample. Who is correct?
   A. Technician A only
   B. Technician B only
   C. Both technicians are correct.
   D. Neither technician is correct.

WLD-L11

Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position

Self-Assessment No. 2 Answer Key

1. a
2. b
3. c
4. c
5. c
6. e
7. d
8. c
9. d
10. d

Name: ______________________________ Date: ___________________________

WLD-L11
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Self-Assessment No. 3

Choose the best answer.

1. The size of the bead is __________ proportional to the speed of travel.
   - A. Directly
   - B. Inversely
   - C. Not
   - D. None of the above

2. The eye shield of the welding helmet should be:
   - A. Just light enough to clearly see the arc.
   - B. Too dark to clearly see the arc.
   - C. A minimum of #5.
   - D. None of the above.

3. Welding in confined spaces may require:
   - A. Air supplied hoods or hose masks.
   - B. Frequent breaks.
   - C. Large, high-displacement fans.
   - D. All of the above.
   - E. None of the above.

4. Long sleeves protect the arms against:
   - A. Ultraviolet radiation.
   - B. Infrared radiation.
   - C. Welding splatter.
   - D. All of the above.
   - E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
   - A. Current polarity
   - B. Arc length
   - C. Length of the electrode
   - D. All of the above are variables in the process.
   - E. None of the above.

6. Acceptable welding footwear includes:
   - A. Roman sandals.
   - B. Tennis shoes.
   - C. Canvas boots.
   - D. All of the above.
   - E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   - A. Excess convexity.
   - B. Overlap.
   - C. Porosity.
   - D. All of the above.
   - E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   - A. Technician A only.
   - B. Technician B only.
   - C. Both Technicians A and B.
   - D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   - A. DC-.
   - B. DC+.
   - C. AC.
   - D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
    - A. Technician A only.
    - B. Technician B only.
    - C. Both Technicians A and B.
    - D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
    - A. Technician A only.
    - B. Technician B only.
    - C. Both Technicians A and B.
    - D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
    A. On.
    B. Off.
    C. On or off, depending on the repair.
    D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
    A. On rubber work mats.
    B. Elevated off the floor.
    C. Grounded.
    D. All of the above.
    E. None of the above.

14. Which of the following electrodes is NOT in the low-hydrogen family?
    A. E7015
    B. E7016
    C. E7018
    D. All of the above are low-hydrogen electrodes.
    E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

16. Fire inspections should be continued for at least __________ after completion of the welding.
    A. Fifteen minutes
    B. Thirty minutes
    C. One hour
    D. Two hours

17. The welding area should be:
    A. Isolated from other workers by shields.
    B. At least 35 feet from combustible materials.
    C. Dry.
    D. All of the above.
    E. None of the above.

18. Seam welds generally require _____________ oscillation.
A. No
B. Very little
C. Moderate
D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?
A. Technician A only.
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:
A. Do not weld
B. Take frequent breaks to inspect the area for fires
C. Station a fire watcher near the combustible materials
D. Any of the above is acceptable
E. None of the above

21. E7018 electrodes should never be used with
A. DC-
B. DC+
C. AC
D. There is no such electrode

22. Areas to be welded should be thoroughly cleaned
A. Prior to fit-up
B. By brushing, sanding, or grinding
C. With safe solvents
D. All of the above, as necessary
E. None of the above

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?
A. Technician A only
B. Technician B only
C. Both Technicians A and B
D. Neither Technician A nor B

24. Low-hydrogen electrodes may be stored
   A. In sealed cans or heated rod ovens
   B. Under water
   C. In petroleum jelly
   D. Any of the above
   E. None of the above

25. As the material being welded increases in thickness, the travel speed of the weld must
   A. Increase
   B. Decrease
   C. Either A or B, depending on the desired effect
   D. Stay the same
   E. None of the above

WLD-L11
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Self-Assessment No. 3 Answer Key

1.	b
2.	a
3.	a
4.	d
5.	c
6.	e
7.	e
8.	c
9.	b
10.	c
11.	c
12.	b
13.	c
14.	d
15.	a
16.	b
17.	d
18.	b
19.	c
20.	c
21.	a
22.	d
23.	b
24.	a
25.	b

WELDER SERIES

MASTER Technical Module No. WLD-L12

SUBJECT: **WELDING TECHNICIAN** **TIME: 15 HOURS**

- **DUTY:** **SHIELDED METAL ARC WELDING (SMAW) (ADVANCED)**
- **TASK:** Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe in the 6G Position

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Set-up work area and equipment;
B. Set-up work piece; and,
C. Weld test piece according to specifications.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on pipe welding
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
Miller Module Method Video materials
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Shielded Metal Arc Welding machine
Welding shop tools
Selection of base metals for welding and cutting
Selection of filler metals and electrode wire
MASTER Handout No. 1 (WLD-L12-HO1)
MASTER Handout No. 2 (WLD-L12-HO2)
MASTER Handout No. 3 (WLD-L12-HO3)
MASTER Handout No. 4 (WLD-L12-HO4)
MASTER Handout No. 5 (WLD-L12-HO5)
MASTER Handout No. 6 (WLD-L12-HO6)
MASTER Laboratory Aid (WLD-L12-LA)
MASTER Laboratory Worksheet (WLD-L12-LW)
MASTER Self-Assessment No. 1
MASTER Self-Assessment No. 2
MASTER Self-Assessment No. 3

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Reading Welding Blueprints & Symbols, Stinchcomb, Craig, New Jersey: Prentice-Hall, Inc., Latest Edition
Certification Manual For Welding Inspector, American Welding Society, Miami, FL, (ISBN 0-87171-421-3) Latest Edition
Welding Qualifications, Practical Guide to ASME Section IX, Houle, Michael J., *CASTI* Publishing, Inc., Canada, (ISBN 0-9696428-5-7), Latest Edition
The Procedure Handbook of Arc Welding; The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses.

WLD-L1	"Preheat Joint"
WLD-L2	"Initiate Welding Process"
WLD-L3	"Perform Weld Sequence"
WLD-L4	"Control Weld Technique"
WLD-L5	"Maintain Preheat and Perform Interpass"
WLD-L6	"Use the Carbon Arc Process to Cut and Gouge Weld Materials"
WLD-L7	"Apply Welders Identification"
WLD-L8	"Control Post-Weld Temperature According to Procedures"
WLD-L9	"Post Clean Weld"
WLD-L10	"Post Finish Weld"

WLD-L11 "Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe in the 6G Position"

INTRODUCTION:

The Course Introduction will Include:

- An overview of certification procedures for pipe welding
- A class demonstration of effective welding techniques required for certification
- A discussion on additional training activities that can lead to certification.

PRESENTATION OUTLINE:

Instructor Topics:

A. Considerations and principles involved in the welding of pipe with SMAW
B. Joint design and welding terms for pipe welding
C. Interpret drawings and blueprints for pipe welding
D. The proper application of welding skills for pipe welding
E. The adequate preparation of welding surfaces for pipe welding
F. Skill levels needed to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Demonstrate preheat and how to maintain desired temperature
I. Identify welding variables and their effects on weld quality
J. Identify the AISI steel classification system
K. Match SMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform pipe welds in multiple positions
C. Use welding techniques appropriate for pipe welding
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible. Employer certification in pipe welding, as well as AWS certification, is the goal of the professional welder.

EVALUATION AND/OR VERIFICATION:

The major examinations should result in certification.

SUMMARY:

Emphasis is placed upon skills necessary to pass a SMAW performance qualification test in pipe welding.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M1) dealing with identifying GMAW equipment.

WLD-L12-HO1
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Set-up work area and equipment;
B. Set-up work piece; and,
C. Weld test piece according to specifications.

MODULE OUTLINE:

Instructor Topics:

A. Considerations and principles involved in the welding of pipe with SMAW
B. Joint design and welding terms for pipe welding
C. Interpret drawings and blueprints for pipe welding
D. The proper application of welding skills for pipe welding
E. The adequate preparation of welding surfaces for pipe welding
F. Skill levels needed to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Demonstrate preheat and how to maintain desired temperature
I. Identify welding variables and their effects on weld quality
J. Identify the AISI steel classification system
K. Match SMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform pipe welds in multiple positions
C. Use welding techniques appropriate for pipe welding
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-L12-HO2

Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
    A. Hardening for utility
    B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
    A. Brine (water and sodium chloride or sodium hydroxide)
    B. Water
    C. Fused (liquid) salts
    D. Molten lead
    E. Soluble oil and water
    F. Oil
    G. Air
IV. Estimate Metal Heat Temperature by Color
    A. Use of temper color chart for tempering
    B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L12-HO3
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
  A. Imprecise method, good for rough estimates only
  B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
  A. High-carbon steels show more spark bursts than do low-carbon steels.
  B. Non-ferrous metals
    1. Aluminum
    2. Magnesium
    3. Brass
    4. Bronze
    5. Nickel
    6. Tin
    7. Others
III. Perform Rockwell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
  A. Ferrous metals
  B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L12-HO4
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly

    b. Operate welding helmet
    c. Verbally warn others of intent to arc weld
    d. Strike an arc
    e. Weld with stringer bead technique
    f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
    a. Maintain required weld quality
    b. Maintain proper weld width uniformly
    c. Maintain proper travel speed
    d. Match correct oscillation for various electrodes
    e. Match applications to weave techniques, as they apply
    f. List the advantages and disadvantages of weave techniques
    g. List the advantages and disadvantages of stringer techniques
    h. Perform weld using weave technique
    i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
    a. Weld a dam to outline area being welded for each layer
    b. Apply each layer neatly, straight and with good fusion throughout
    c. Chip slag after each pass
    d. Weld passes which over lap to crown of last weld bead
    e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
    a. Follow manufacturer's recommended practice
    b. Inspect equipment and work area for safety
    c. Assemble oxy-fuel equipment
    d. Open fuel gas cylinder ½ turn
    e. Open oxygen as cylinder all the way
    f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
    g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    a. Make manual free hand straight line cuts
    b. Cut manually straight lines using cutting jib
    c. Bevel plate with manual oxy-fuel equipment
    d. Manually cut blind holes in thick material
    e. Manually cut sheet metal with minimal distortion

WLD-L12-HO5
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
h. Chip slag and wire brush weld
i. Grind any lack of fusion and/or high spots
j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
k. Visually inspect weld on the root and face sides to ASME Section 9
l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Weld pipe joint
   h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Roll weld pipe
   h. Place pipe coupon on workbench in the 1G roll welding position.
   i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
l. Visually inspect weld on the root and face sides to ASME Section 9
m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L12-HO6
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    a. Produce end preparations with oxy-fuel cutting
    b. Produce end preparations with plasma cutting
    c. Produce end preparations with mechanical cutting
    d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    a. Cut and single bevel pipe to 37 1/2°
    b. Ground bevel face and touch up to within tolerances
    c. Check that pipe ends are square within given tolerances
    d. Prepare root face within given tolerances
    e. Align pipe to within given tolerances
    f. Set root opening to within given tolerances
    g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    b. Weld remainder of pipe in the 1G roll welding position with E6010
    c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    a. Weld using 1/8" E6010
    b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    d. Weld root pass to ASME Section 9 requirements
    e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    a. Fit and tack weld pipe to within tolerances
    b. Place pipe in the 5G position
    c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements

    - d. Grind the finished root pass to remove high spots and any slag at weld toes
    - e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
    - a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
    - b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
    - c. Weld remainder of pipe in 1G position using E7018
    - d. Perform low hydrogen starts and stops
    - e. Weld using stringer bead technique
    - f. Weld using weave technique
    - g. Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
    - a. Use 1/8" E6010
    - b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
    - c. Fit together two pipe ends to a single V edge preparation within given tolerances
    - c. Weld root pass to ASME Section 9 requirements
    - d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
    - e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
    - a. Set up GMAW equipment
    - b. Adjust wire feeder drive system
    - c. Adjust shielding gas system and flow rate
    - d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
    - e. Set welding condition for short circuit transfer - Wire Feed Speed
    - f. Set welding condition for short circuit transfer - Voltage
    - g. Set welding condition for short circuit transfer - Tip to work Distance
    - h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
    - a. Bevel pipe ends
    - b. Touch up bevel face with grinder
    - c. Fit and tack backing ring to one pipe end
    - d. Fit other pipe over backing ring
    - e. Adjust gap and tack in place
    - f. Adjust shielding gas flow
    - g. Adjust wire feed system
    - h. Adjust power source to procedure specification
    - i. Set wire feed speed to procedure specification

j. Adjust voltage to procedure specification
k. Adjust inductance to procedure specification
l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L12-LA
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: **Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.**

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: **Electrical shock can be avoided by following specific safety precautions.**

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.

B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: **NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.**
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L12-LW
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current

DC+(DCRP) Direct Current Reverse Polarity

DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. **Prepare Weldment for Welding**

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

- a. Weld joint configuration will depend upon:
  - (1) Product design
  - (2) Material thickness
  - (3) Design strength requirements
  - (4) Welding process employed
- b. SMAW weld joint configuration may be a:
  - (1) Lap joint
  - (2) Tee joint
  - (3) Corner joint
  - (4) Edge joint
  - (5) Butt joint with backing
  - (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up

- a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
- b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.

- a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
- b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
- c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely

related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.
b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

Name ______________________ Date ______________________

WLD-L12
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Self-Assessment No. 1

Circle the best answer.

1. What is the approximate temperature required for stress relief annealing of low-carbon steels?
   - A. 950°
   - B. 1000°
   - C. 1950°
   - D. 1700°
   - E. None of the above

2. What crystalline processes result from stress relief annealing?
   - A. All grains reform into softer grains
   - B. Distorted grains reform into softer grains
   - C. Ferrite grains reform into softer grains while pearlite grains are basically unaffected
   - D. Pearlite grains reform into softer grains while ferrite grains are basically unaffected
   - E. None of the above

3. Which of the following is NOT a cause of quenching cracks?
   - A. Improper quenching medium
   - B. Overheating during the austenitizing cycle
   - C. Improper quenching angle
   - D. All of the above are causes of quenching cracks
   - E. None of the above answers is correct

4. Which of the following is NOT a characteristic of typical quench cracks?
   - A. The fracture tends to run from the surface toward the center in a smooth curve
   - B. Untempered quench cracks will not show any decarburization
   - C. Tempered fracture surfaces will show a fine crystalline structure
   - D. All of the above are characteristic of quench cracks
   - E. None of the above

5. During tempering by color, which of the following colors represents the highest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

6. During tempering by color, which of the following colors represents the lowest temperature?
   - A. Gold
   - B. Purple
   - C. Dark Straw
   - D. Pale Blue
   - E. Violet

7. What is meant by *step quenching*?
   - A. The workpiece is first quenched in a slow medium (e.g., air) then in a fast medium (e.g., water)
   - B. The workpiece is first quenched in a fast medium (e.g., water) then in a slow medium (e.g., air)
   - C. The weaker parts of the workpiece are quenched separately from the main body of the workpiece
   - D. The workpiece is lowered into the quenching medium in steps so that different parts of the workpiece attain different hardnesses
   - E. None of the above

8. What is the simplest thing that the technician can do to minimize the vapor-blanket stage of liquid quenching?
   - A. Agitate the workpiece or the medium
   - B. Heat the quenching medium to just below its boiling point
   - C. Quickly insert the workpiece into the medium
   - D. Slowly insert the workpiece into the medium
   - E. None of the above

9. Liquid carburizing, as used in case hardening, utilizes __________ and is therefore extremely dangerous.
   - A. Sodium chloride
   - B. Calcium carbonate
   - C. Cyanide salts
   - D. Ammonia
   - E. None of the above

10. Workpieces which have been cut with an oxyacetylene torch often display edge hardness because

A. The torch was starved for oxygen
B. The workpiece was cut at too low a temperature
C. The wrong type of cutting torch was used
D. Oxyacetylene torches always leave hardened edges
E. None of the above

WLD-L12
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Self-Assessment No. 1 Answer Key

1. a
2. c
3. d
4. a
5. c
6. d
7. b
8. a
9. c
10. a

Name ______________________________ Date ____________________

WLD-L12
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Self-Assessment No. 2

Circle the best answer.

1. The *hardness* of a metal is its ability to resist:
    A. Permanent deformation.
    B. Oxidation.
    C. Chemical reaction.
    D. All of the above answers are forms of hardness.
    E. None of the above.

2. Rockwell testing machines test the sample metal's resistance to:
    A. Abrasion.
    B. Penetration.
    C. Elastic deformation.
    D. Electricity.
    E. None of the above.

3. Materials such as nitrided steel and hard cast irons generally have Rockwell hardness numbers in excess of
    A. B-50.
    B. B-75.
    C. B- 100.
    D. B-150.
    E. None of the above.

4. During the file test, if the file will mark the metal but not cut into it, then the metal should be treated as:
    A. High-alloy steel.
    B. Mild steel.
    C. Hardened tool steel.
    D. Medium-carbon steel.
    E. None of the above.

5. Probably the best use of the spark test is to:
    A. Determine the alloy content of the sample.
    B. Identify cast iron.
    C. Compare the sample to a known piece.
    D. All of the above answers are valid.
    E. None of the above.

6. Tool steel has a Rockwell hardness of __________, while hardened tool steel has hardness number of __________.
   - A. C-42 - C-64
   - B. C-42 - B-65
   - C. C-64 - C-42
   - D. B-65 - C-42
   - E. None of the above.

7. Which of the following surfaces should be avoided when hardness testing?
   - A. Curved
   - B. Rough
   - C. Decarburized
   - D. All of the above surfaces should be modified before testing the sample's hardness.
   - E. None of the above.

8. For hardness testing, the minimum recommended clearance from the edge is:
   - A. 1/2"
   - B. 1/4"
   - C. 1/8"
   - D. 1/16"
   - E. None of the above.

9. If a Rockwell tester is in daily use, it should be calibrated:
   - A. Annually.
   - B. Monthly.
   - C. Weekly.
   - D. Daily.
   - E. Never

10. Technician A says that, for large samples, multiple hardness test should be made and their results averaged. Technician B says that many materials vary in hardness over the length of the sample. Who is correct?
    - A. Technician A only
    - B. Technician B only
    - C. Both technicians are correct.
    - D. Neither technician is correct.

WLD-L12

Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position

Self-Assessment No. 2 Answer Key

1.	a
2.	b
3	c
4.	c
5	c
6.	e
7.	d
8	c
9.	d
10	d

Name: ______________________________ Date: ______________________

WLD-L12
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Self-Assessment No. 3

Choose the best answer.

1. The size of the bead is __________ proportional to the speed of travel.
   - A. Directly
   - B. Inversely
   - C. Not
   - D. None of the above

2. The eye shield of the welding helmet should be:
   - A. Just light enough to clearly see the arc.
   - B. Too dark to clearly see the arc.
   - C. A minimum of #5.
   - D. None of the above.

3. Welding in confined spaces may require:
   - A. Air supplied hoods or hose masks.
   - B. Frequent breaks.
   - C. Large, high-displacement fans.
   - D. All of the above.
   - E. None of the above.

4. Long sleeves protect the arms against:
   - A. Ultraviolet radiation.
   - B. Infrared radiation.
   - C. Welding splatter.
   - D. All of the above.
   - E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
   - A. Current polarity
   - B. Arc length
   - C. Length of the electrode
   - D. All of the above are variables in the process.
   - E. None of the above.

6. Acceptable welding footwear includes:
   A. Roman sandals.
   B. Tennis shoes.
   C. Canvas boots.
   D. All of the above.
   E. None of the above.

7. A welder whose travel speed is too fast may have problems with:
   A. Excess convexity.
   B. Overlap.
   C. Porosity.
   D. All of the above.
   E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   A. DC-.
   B. DC+.
   C. AC.
   D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
    A. On.
    B. Off.
    C. On or off, depending on the repair.
    D. The SMAW machine is not electrical.

13. To prevent electrical shocks, all electrical equipment and the work piece should be:
    A. On rubber work mats.
    B. Elevated off the floor.
    C. Grounded.
    D. All of the above.
    E. None of the above.

14. Which of the following electrodes is NOT in the low-hydrogen family?
    A. E7015
    B. E7016
    C. E7018
    D. All of the above are low-hydrogen electrodes.
    E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current. Technician B says that wet electrodes can also cause undercutting. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

16. Fire inspections should be continued for at least __________ after completion of the welding.
    A. Fifteen minutes
    B. Thirty minutes
    C. One hour
    D. Two hours

17. The welding area should be:
    A. Isolated from other workers by shields.
    B. At least 35 feet from combustible materials.
    C. Dry.
    D. All of the above.
    E. None of the above.

18. Seam welds generally require ____________ oscillation.
   - A. No
   - B. Very little
   - C. Moderate
   - D. Great

19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?
   - A. Technician A only.
   - B. Technician B only
   - C. Both Technicians A and B
   - D. Neither Technician A nor B

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:
   - A. Do not weld
   - B. Take frequent breaks to inspect the area for fires
   - C. Station a fire watcher near the combustible materials
   - D. Any of the above is acceptable
   - E. None of the above

21. E7018 electrodes should never be used with
   - A. DC-
   - B. DC+
   - C. AC
   - D. There is no such electrode

22. Areas to be welded should be thoroughly cleaned
   - A. Prior to fit-up
   - B. By brushing, sanding, or grinding
   - C. With safe solvents
   - D. All of the above, as necessary
   - E. None of the above

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?
   - A. Technician A only
   - B. Technician B only
   - C. Both Technicians A and B
   - D. Neither Technician A nor B

24. Low-hydrogen electrodes may be stored

    A. In sealed cans or heated rod ovens
    B. Under water
    C. In petroleum jelly
    D. Any of the above
    E. None of the above

25. As the material being welded increases in thickness, the travel speed of the weld must

    A. Increase
    B. Decrease
    C. Either A or B, depending on the desired effect
    D. Stay the same
    E. None of the above

WLD-L12
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Self-Assessment No. 3 Answer Key

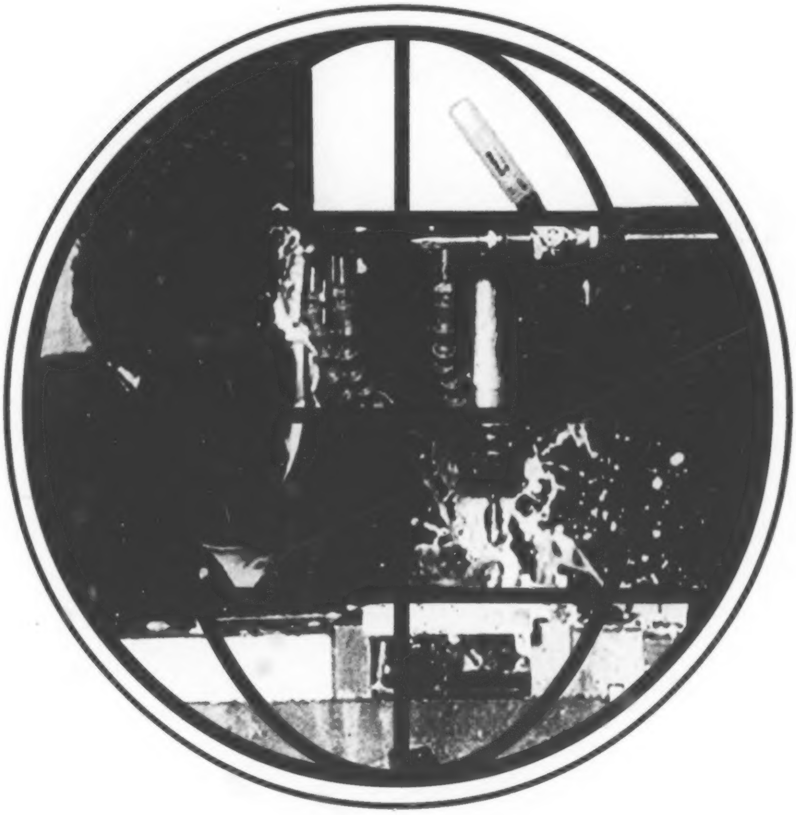
1. b
2. a
3. a
4. d
5. c
6. e
7. e
8. c
9. b
10. c
11. c
12. b
13. c
14. d
15. a
16. b
17. d
18. b
19. c
20. c
21. a
22. d
23. b
24. a
25. b

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY



Welding Series

INSTRUCTOR'S HANDBOOK

DUTIES M1 THROUGH U

Supported by the National Science Foundation's Advanced Technological Education Program

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDa.PM0
072300

Duty M1

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post-finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on lilfe of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-M1

WELDER SERIES

MASTER Technical Module No. WLD-M01

SUBJECT: WELDING TECHNICIAN TIME: 6 HOURS

- **DUTY: GAS METAL ARC WELDING (GMAW) (BASIC)**
- **TASK:** Identify GMAW Equipment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Safely identify and inspect gas metal arc welding equipment and accessories, and shielding gas equipment and accessories;

B. Understand ANSI A49.1, ***Safety in Welding, Cutting and Allied Processes, Part II-Specific Processes, 11. Arc Welding and Cutting Equipment Safety***;

C. Perform routine safety inspections of protective equipment and clothing, gas metal arc welding equipment and accessories, shielding gas equipment and accessories, required tools and the work area; and,

D. Understand welding related terms and definitions.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on Safety and GMAW Procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M1-HO1)
MASTER Handout No. 2 (WLD-M1-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of GMAW equipment and shielding gas equipment
- A class demonstration on safe start-up and operation of equipment
- A discussion on training activities resulting in an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences in equipment from previous classes
B. Illustrate safety and preventive practices
C. GMAW welding variables and adjustments to equipment

D. The most common GMAW welding applications
E. GMAW filler metal classification by AWS standards
F. Shielding gases used with GMAW
G. Power sources used with GMAW

Student Activities:

A. Select and use personal protective equipment for GMAW
B. Set up equipment for GMAW process
C. Understand the operation and purpose of the wire feeder control system
D. Discuss use of shielding gases
E. Understand the power source operation and the output curve characteristics of both constant current and constant potential power sources

---

PRACTICAL APPLICATION:

The student will gain theoretical knowledge of GMAW operational concepts and principles, and gain the practical knowledge of equipment identification for use.

EVALUATION AND/OR VERIFICATION:

An examination will be given in this module to determine student progress. Student participation in identification and equipment assembly will also be evaluated by the instructor.

SUMMARY:

The student will understand the GMAW process and the function of GMAW equipment. The gas metal arc welding (GMAW) process was first developed in 1948. It was a natural development based somewhat on the idea of the gas tungsten arc welding (GTAW) process. The principal difference in the two welding processes is that the GTAW process uses non-consumable tungsten electrodes. The GMAW process uses continuous solid wire consumable electrodes. There are also some differences in the shielding gases. The gas metal arc welding process requires a constant voltage (constant potential) DC welding power source, some method of controlling and feeding the electrode wire to the arc, and some type of hose/cable assembly and gun through which the electrode wire reaches the welding arc. Electrical contact is made at the barrel end of the gun, through a copper contact tube, to electrically energize the welding electrode. Some type of shielding gas is used with this process. The shielding gas may be inert or chemically active to the base metal. The speed of metal deposition will vary depending on the method of metal transfer used, the shielding gas, the electrode type and diameter, the welding position, and the base metal classification. In almost every instance the gas metal arc welding process is faster than the shielded metal arc welding process.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M2) dealing with identifying the safety hazards.

WLD-M1-HO1
Identify GMAW Equipment
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Safely identify and inspect gas metal arc welding equipment and accessories, and shielding gas equipment and accessories;

B. Understand ANSI A49.1, ***Safety in Welding, Cutting and Allied Processes, Part II-Specific Processes, 11. Arc Welding and Cutting Equipment Safety***;

C. Perform routine safety inspections of protective equipment and clothing, gas metal arc welding equipment and accessories, shielding gas equipment and accessories, required tools and the work area; and,

D. Understand welding related terms and definitions.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences in equipment from previous classes

B. Illustrate safety and preventive practices

C. GMAW welding variables and adjustments to equipment

D. The most common GMAW welding applications

E. GMAW filler metal classification by AWS standards

F. Shielding gases used with GMAW

G. Power sources used with GMAW

Student Activities:

A. Select and use personal protective equipment for GMAW

B. Set up equipment for GMAW process

C. Understand the operation and purpose of the wire feeder control system

D. Discuss use of shielding gases

E. Understand the power source operation and the output curve characteristics of both constant current and constant potential power sources

WLD-M1-HO2
Identify GMAW Equipment
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

- a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
- b. Choose the correct electrode for given material and applications both type and size
- c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld 1/4" fillet welds in 2F position using string bead technique
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   - g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30□ bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

Name: ______________________________ Date: ______________________

WLD-M1
Perform GMAW Basic
Self-Assessment

Circle the best answer.

1. What polarity does MIG normally run on?
   - A. AC
   - B. Electrode Negative
   - C. Electrode Positive
   - D. Both A and C
   - E. None of the above

2. Spray MIG Welding is used to weld what thickness metal?
   - A. Thick
   - B. Thin

3. How do you change the amperage when MIG Welding?
   - A. Wire feed speed
   - B. Current setting
   - C. Voltage setting
   - D. None of the above

4. What does the gas do for MIG Welding?
   - A. Cleans the base metal
   - B. Burns and makes heat which helps melt the base metal
   - C. Forces the weld metal onto the base plate
   - D. Keeps air away from the molten weld pool
   - E. None of the above

5. Short Circuit MIG Welding is used to weld what thickness of metal?
   - A. Thick
   - B. It is not used with MIG
   - C. Thin
   - D. Thick aluminum only
   - E. None of the above

6. With MIG Welding, what technique is usually used?
   - A. Push
   - B. Pull
   - C. Whip
   - D. Spot
   - E. None of the above

7. Why is a spatter buildup on the inside of the nozzle harmful to a good weld?
   - A. Stops the electrode
   - B. Stops the gas
   - C. Stops the polarity
   - D. Causes too much voltage
   - E. None of the above

8. What should the shielding gas be set at for MIG Welding?
   - A. 5 ech
   - B. 15 psi
   - C. 30 psi
   - D. 25 cfh
   - E. 5 psi

9. What is ER 70S-3?
   - A. Shielding gas
   - B. Miller MIG Welder
   - C. Lincoln Wire Feeder
   - D. Electrode
   - E. None of the above

10. In MIG welding, what does a flow meter do?
    - A. Controls shielding gas flow
    - B. Measures amperage
    - C. Feeds wire electrode
    - D. Voltage sensing device
    - E. None of the above

11. In MIG welding, what shielding gas makes a rough looking weld with a large amount of spatter?
    - A. 98% argon, 2% oxygen
    - B. 90% argon, 10% Co2
    - C. 100% argon
    - D. 100% Co2
    - E. Both A and B

12. In MIG welding, which shielding gas is used for spray transfer?
    - A. 100% argon
    - B. 100% Co2
    - C. 75% argon, 25% Co2
    - D. 95% argon, 5% oxygen
    - E. All of the above
    - F. None of the above

13. In MIG welding, what causes electrode stubbing?
    A. Wire feed too high
    B. Wire feed too low
    C. Voltage too high
    D. Voltage too low
    E. Both A and C
    F. None of the above

14. In MIG welding, how long is the stickout?
    A. 1/32”
    B. 3/16”
    C. 3/8”
    D. 3/4”
    E. 1”

15. In MIG welding sheet metal, how do you fill a large gap?
    A. Weave it in
    B. Whipping
    C. Pulse arc with trigger
    D. U-Weave
    E. Both C and D
    F. None of the above

16. In MIG welding, what is the purpose of the drive rolls?
    A. Moves the MIG gun
    B. Guides the MIG gun
    C. Feeds the electrode
    D. Wheels inside gun liner attached to flow meter
    E. None of the above

WELDER SERIES

MASTER Technical Module No. WLD-M02

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **GAS METAL ARC WELDING (GMAW) (BASIC)**
- **TASK:** Identify the Safety Hazards

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Review ventilation requirements;
B. Provide demonstrations related to routine safety inspections of protective equipment and clothing;
C. Provide demonstrations related to ANSI Z49.1; and,
D. Provide demonstrations related to safe handling of shielding gas equipment and accessories.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on safety and welding procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M2-HO1)
MASTER Handout No. 2 (WLD-M2-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of GMAW safety hazards
- A class demonstration of effective use of protective clothing and equipment
- A discussion training activities resulting in an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment

Student Activities:

A. Use personal protective equipment
B. Set up procedure for GMAW process and equipment
C. Perform beginning welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds

PRACTICAL APPLICATION:

This module requires the student to understand and recognize the source of safety hazards for GMAW processes. If welding in confined areas, shielding gas can build up and displace oxygen. Areas must be ventilated properly.

EVALUATION AND/OR VERIFICATION:

An examination will be given in this module to determine student progress.

SUMMARY:

The gas metal arc welding process uses a continuously fed wire for the electrode and filler metal. Welding heat is produced by an arc that is established between the consumable wire electrode and the base metal. Shielding gas is fed into the arc area to protect the weld puddle and base metal from atmospheric contamination.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M3) dealing with describing the preventive and protective measures.

WLD-M2-HO1
Identify the Safety Hazards
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Review ventilation requirements;
B. Provide demonstrations related to routine safety inspections of protective equipment and clothing;
C. Provide demonstrations related to ANSI Z49.1; and,
D. Provide demonstrations related to safe handling of shielding gas equipment and accessories.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment

Student Activities:

A. Use personal protective equipment
B. Set up procedure for GMAW process and equipment
C. Perform beginning welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds

Identify the Safety Hazards

Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a List arc characteristics caused by welding with 100% carbon dioxide
    b List arc characteristics caused by welding with 100% argon
    c List arc characteristics caused by welding with 75% Argon and 25% CO2
    d List arc characteristics caused by welding with 95% Argon and 5% CO2
    e List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b Choose the correct electrode for given material and applications both type and size
    c Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Place the T joint in the 4F overhead position approximately at eye level
   - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
   - a. Inspect the work area and equipment for safety
   - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   - c. Use grind to clean the bevel face and apply a 3/32" root face
   - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   - f. Weld root upwards
   - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   - i. Complete the second pass using GMAW and upward Z weave technique
   - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   - k. Make fourth and final pass with the same technique.
   - l. The electrode is weaved from one bevel edge to another
   - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
   - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

Name: ______________________________ Date: ______________________

WLD-M2

Identify the Safety Hazards

Self-Assessment

Circle the best answer.

1. What polarity does MIG normally run on?
   - A. AC
   - B. Electrode Negative
   - C. Electrode Positive
   - D. Both A and C
   - E. None of the above

2. Spray MIG Welding is used to weld what thickness metal?
   - A. Thick
   - B. Thin

3. How do you change the amperage when MIG Welding?
   - A. Wire feed speed
   - B. Current setting
   - C. Voltage setting
   - D. None of the above

4. What does the gas do for MIG Welding?
   - A. Cleans the base metal
   - B. Burns and makes heat which helps melt the base metal
   - C. Forces the weld metal onto the base plate
   - D. Keeps air away from the molten weld pool
   - E. None of the above

5. Short Circuit MIG Welding is used to weld what thickness of metal?
   - A. Thick
   - B. It is not used with MIG
   - C. Thin
   - D. Thick aluminum only
   - E. None of the above

6. With MIG Welding, what technique is usually used?
   - A. Push
   - B. Pull
   - C. Whip
   - D. Spot
   - E. None of the above

7. Why is a spatter buildup on the inside of the nozzle harmful to a good weld?
   A. Stops the electrode
   B. Stops the gas
   C. Stops the polarity
   D. Causes too much voltage
   E. None of the above

8. What should the shielding gas be set at for MIG Welding?
   A. 5 ech,
   B. 15 psi
   C. 30 psi
   D. 25 cfh
   E. 5 psi

9. What is ER 70S-3?
   A. Shielding gas
   B. Miller MIG Welder
   C. Lincoln Wire Feeder
   D. Electrode
   E. None of the above

10 In MIG welding, what does a flow meter do?
   A. Controls shielding gas flow
   B. Measures amperage
   C. Feeds wire electrode
   D. Voltage sensing device
   E. None of the above

11. In MIG welding, what shielding gas makes a rough looking weld with a large amount of spatter?
   A. 98% argon, 2% oxygen
   B. 90% argon, 10% Co2
   C. 100% argon
   D. 100% Co2
   E. Both A and B

12. In MIG welding, which shielding gas is used for spray transfer?
   A. 100% argon
   B. 100% Co2
   C. 75% argon, 25% Co2
   D. 95% argon, 5% oxygen
   E. All of the above
   F. None of the above

13. In MIG welding, what causes electrode stubbing?
    A. Wire feed too high
    B. Wire feed too low
    C. Voltage too high
    D. Voltage too low
    E. Both A and C
    F. None of the above

14. In MIG welding, how long is the stickout?
    A. 1/32"
    B. 3/16"
    C. 3/8"
    D. 3/4"
    E. 1"

15. In MIG welding sheet metal, how do you fill a large gap?
    A. Weave it in
    B. Whipping
    C. Pulse arc with trigger
    D. U-Weave
    E. Both C and D
    F. None of the above

16. In MIG welding, what is the purpose of the drive rolls?
    A. Moves the MIG gun
    B. Guides the MIG gun
    C. Feeds the electrode
    D. Wheels inside gun liner attached to flow meter
    E. None of the above

WELDER SERIES

MASTER Technical Module No. WLD-M03

SUBJECT: **WELDING TECHNICIAN** **TIME: 2 HOURS**

- **DUTY:** **GAS METAL ARC WELDING (GMAW) (BASIC)**
- **TASK:** Describe the Preventive and Protective Measures

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective;
B. Provide instruction related to ANSI Z49.1;
C. Reinforce previous instruction on safety; and,
D. Observe trainee following safe practices.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on safety and welding procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M3-HO1)
MASTER Handout No. 2 (WLD-M3-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of preventive and protective measures for GMAW
- A class demonstration of effective preventive and protective welding measures
- A discussion on training activities resulting in an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of GMAW equipment as compared to oxyacetylene
B. Illustrate safety and preventive practices
C. Understand ventilation requirements for shielded gases
D. Use proper filter lens in helmet and protective clothing
E. Wear safety glasses, properly ground the welding machine, and secure all cylinders with safety chains or cables
F. Illustrate welding variables and adjustments to equipment

Student Activities:

A. Use preventive measures and wear protective equipment

B. Set up procedure to be followed for GMAW process and equipment
C. Perform beginning welds on T fillets and butt-joints with various metals and filler wire using single and multi-pass welds

PRACTICAL APPLICATION

The student will use preventive measures and wear protective equipment. The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

An examination will be given in this module to determine student progress. Instructor will monitor the student in the use of preventive measures and wearing of protective equipment.

SUMMARY:

The emphasis in this module is the need to follow procedural and prescriptive methods. The use of preventive measures to reduce hazards and follow procedures in the use of protective clothing must be understood by the student.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M4) dealing with identifying welding variables and their effects upon weld quality.

WLD-M3-HO1
Describe the Preventive and Protective Measures
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective;
B. Provide instruction related to ANSI Z49.1;
C. Reinforce previous instruction on safety; and,
D. Observe trainee following safe practices.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of GMAW equipment as compared to oxyacetylene
B. Illustrate safety and preventive practices
C. Understand ventilation requirements for shielded gases
D. Use proper filter lens in helmet and protective clothing
E. Wear safety glasses, properly ground the welding machine, and secure all cylinders with safety chains or cables
F. Illustrate welding variables and adjustments to equipment

Student Activities:

A. Use preventive measures and wear protective equipment
B. Set up procedure to be followed for GMAW process and equipment
C. Perform beginning welds on T fillets and butt-joints with various metals and filler wire using single and multi-pass welds

WLD-M3-HO2
Describe the Preventive and Protective Measures
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a Inspect area for safety
   b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c Adjust the welding parameters for this task
   d Tack a T joint using GMAW
   e Weld the second pass with electrode centered at the bottom toe of the first pass
   f Weld the third pass with electrode centered at the top toe of the second pass
   g Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a Inspect area for safety
   b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO_2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

Name: ______________________________ Date: ______________________

WLD-M3

Describe the Preventive and Protective Measures

Self-Assessment

Circle the best answer.

1. What polarity does MIG normally run on?
   - A. AC
   - B. Electrode Negative
   - C. Electrode Positive
   - D. Both A and C
   - E. None of the above

2. Spray MIG Welding is used to weld what thickness metal?
   - A. Thick
   - B. Thin

3. How do you change the amperage when MIG Welding?
   - A. Wire feed speed
   - B. Current setting
   - C. Voltage setting
   - D. None of the above

4. What does the gas do for MIG Welding?
   - A. Cleans the base metal
   - B. Burns and makes heat which helps melt the base metal
   - C. Forces the weld metal onto the base plate
   - D. Keeps air away from the molten weld pool
   - E. None of the above

5. Short Circuit MIG Welding is used to weld what thickness of metal?
   - A. Thick
   - B. It is not used with MIG
   - C. Thin
   - D. Thick aluminum only
   - E. None of the above

6. With MIG Welding, what technique is usually used?
   - A. Push
   - B. Pull
   - C. Whip
   - D. Spot
   - E. None of the above

7. Why is a spatter buildup on the inside of the nozzle harmful to a good weld?
A. Stops the electrode
B. Stops the gas
C. Stops the polarity
D. Causes too much voltage
E. None of the above

8. What should the shielding gas be set at for MIG Welding?
A. 5 ech
B. 15 psi
C. 30 psi
D. 25 cfh
E. 5 psi

9. What is ER 70S-3?
A. Shielding gas
B. Miller MIG Welder
C. Lincoln Wire Feeder
D. Electrode
E. None of the above

10. In MIG welding, what does a flow meter do?
A. Controls shielding gas flow
B. Measures amperage
C. Feeds wire electrode
D. Voltage sensing device
E. None of the above

11. In MIG welding, what shielding gas makes a rough looking weld with a large amount of spatter?
A. 98% argon, 2% oxygen
B. 90% argon, 10% Co2
C. 100% argon
D. 100% Co2
E. Both A and B

12. In MIG welding, which shielding gas is used for spray transfer?
A. 100% argon
B. 100% Co2
C. 75% argon, 25% Co2
D. 95% argon, 5% oxygen
E. All of the above
F. None of the above

13. In MIG welding, what causes electrode stubbing?
   A. Wire feed too high
   B. Wire feed too low
   C. Voltage too high
   D. Voltage too low
   E. Both A and C
   F. None of the above

14. In MIG welding, how long is the stickout?
   A. 1/32"
   B. 3/16"
   C. 3/8"
   D. 3/4"
   E. 1"

15. In MIG welding sheet metal, how do you fill a large gap?
   A. Weave it in
   B. Whipping
   C. Pulse arc with trigger
   D. U-Weave
   E. Both C and D
   F. None of the above

16. In MIG welding, what is the purpose of the drive rolls?
   A. Moves the MIG gun
   B. Guides the MIG gun
   C. Feeds the electrode
   D. Wheels inside gun liner attached to flow meter
   E. None of the above

WELDER SERIES

MASTER Technical Module No. WLD-M04

SUBJECT: WELDING TECHNICIAN **TIME:** 6 HOURS

- **DUTY:** GAS METAL ARC WELDING (GMAW) (BASIC)
- **TASK:** Identify Welding Variables and Their Effects Upon Weld Quality

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to gas metal arc welding equipment and accessory set up;
B. Provide demonstrations related to shielding gas equipment and accessory set up;
C. Demonstrate gas metal arc welding principles of operation;
D. Identify the shielding gases relevant to the gas metal arc welding process;
E. Understand the gas metal arc welding filler metal identification and selection process;
F. Introduce related terms and definitions;
G. Follow safe practices;
H. Set up gas metal arc welding equipment and accessories;
I. Set up shielding gas equipment and accessories;
J. Develop and administer formative or diagnostic tests relevant to gas metal arc welding principals; and,
K. Demonstrate proficiency in the gas metal arc welding principles of operation, and filler metal identification/selection,

---

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on welding principles and quality welding procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders

Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M4-HO1)
MASTER Handout No. 2 (WLD-M4-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need to identify welding variables and understand their affects on weld quality
- A class demonstration of effective GMAW techniques
- A discussion on training activities resulting in an increase of skills and knowledge

PRESENTATION OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment
D. Describe the most common GMAW weldability problems
E. Illustrate GMAW filler metal classification by AWS standards
F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Perform Welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
C. Discuss welding variables to include:
    1. Filler metal classification
    2. Material thickness
    3. Joint design
    4. Type of base metal
    5. Welding process
    6. Amperage
    7. Travel speed
    8. Shielding gas flow

PRACTICAL APPLICATION:

The student will understand the need for controlling weld variables. The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

An examination will be given in this module to determine student progress. Student will also demonstrate knowledge and control of GMAW variables in the laboratory exercises.

SUMMARY:

The planning of welding activities requires an understanding of weld variables, their potential impact on outcomes of the process, and the need for their control and adjustment, based upon approved procedures and professional judgment.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M5) dealing with troubleshooting equipment.

WLD-M4-HO1

Identify Welding Variables and Their Effects Upon Weld Quality

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to gas metal arc welding equipment and accessory set up;
B. Provide demonstrations related to shielding gas equipment and accessory set up;
C. Demonstrate gas metal arc welding principles of operation;
D. Identify the shielding gases relevant to the gas metal arc welding process;
E. Understand the gas metal arc welding filler metal identification and selection process;
F. Introduce related terms and definitions;
G. Follow safe practices;
H. Set up gas metal arc welding equipment and accessories;
I. Set up shielding gas equipment and accessories;
J. Develop and administer formative or diagnostic tests relevant to gas metal arc welding principals; and,
K. Demonstrate proficiency in the gas metal arc welding principles of operation, and filler metal identification/selection,

---

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment
D. Describe the most common GMAW weldability problems
E. Illustrate GMAW filler metal classification by AWS standards
F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Perform Welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
C. Discuss welding variables to include:
    1. Filler metal classification
    2. Material thickness
    3. Joint design
    4. Type of base metal
    5. Welding process

6. Amperage
7. Travel speed
8. Shielding gas flow

WLD-M4-HO2
Identify Welding Variables and Their Effects Upon Weld Quality
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on-6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

Name: ______________________________ Date: ______________________

WLD-M4
Identify Welding Variables and Their Effects Upon Weld Quality
Self-Assessment

Circle the best answer.

1. What polarity does MIG normally run on?
   A. AC
   B. Electrode Negative
   C. Electrode Positive
   D. Both A and C
   E. None of the above

2. Spray MIG Welding is used to weld what thickness metal?
   A. Thick
   B. Thin

3. How do you change the amperage when MIG Welding?
   A. Wire feed speed
   B. Current setting
   C. Voltage setting
   D. None of the above

4. What does the gas do for MIG Welding?
   A. Cleans the base metal
   B. Burns and makes heat which helps melt the base metal
   C. Forces the weld metal onto the base plate
   D. Keeps air away from the molten weld pool
   E. None of the above

5. Short Circuit MIG Welding is used to weld what thickness of metal?
   A. Thick
   B. It is not used with MIG
   C. Thin
   D. Thick aluminum only
   E. None of the above

6. With MIG Welding, what technique is usually used?
   A. Push
   B. Pull
   C. Whip
   D. Spot
   E. None of the above

7. Why is a spatter buildup on the inside of the nozzle harmful to a good weld?
    A. Stops the electrode
    B. Stops the gas
    C. Stops the polarity
    D. Causes too much voltage
    E. None of the above

8. What should the shielding gas be set at for MIG Welding?
    A. 5 ech
    B. 15 psi
    C. 30 psi
    D. 25 cfh
    E. 5 psi

9. What is ER 70S-3?
    A. Shielding gas
    B. Miller MIG Welder
    C. Lincoln Wire Feeder
    D. Electrode
    E. None of the above

10. In MIG welding, what does a flow meter do?
    A. Controls shielding gas flow
    B. Measures amperage
    C. Feeds wire electrode
    D. Voltage sensing device
    E. None of the above

11. In MIG welding, what shielding gas makes a rough looking weld with a large amount of spatter?
    A. 98% argon, 2% oxygen
    B. 90% argon, 10% Co2
    C. 100% argon
    D. 100% Co2
    E. Both A and B

12. In MIG welding, which shielding gas is used for spray transfer?
    A. 100% argon
    B. 100% Co2
    C. 75% argon, 25% Co2
    D. 95% argon, 5% oxygen
    E. All of the above
    F. None of the above

13. In MIG welding, what causes electrode stubbing?
A. Wire feed too high
B. Wire feed too low
C. Voltage too high
D. Voltage too low
E. Both A and C
F. None of the above

14. In MIG welding, how long is the stickout?
A. 1/32"
B. 3/16"
C. 3/8"
D. 3/4"
E. 1"

15. In MIG welding sheet metal, how do you fill a large gap?
A. Weave it in
B. Whipping
C. Pulse arc with trigger
D. U-Weave
E. Both C and D
F. None of the above

16. In MIG welding, what is the purpose of the drive rolls?
A. Moves the MIG gun
B. Guides the MIG gun
C. Feeds the electrode
D. Wheels inside gun liner attached to flow meter
E. None of the above

WELDER SERIES

MASTER Technical Module No. WLD-M05

SUBJECT: WELDING TECHNICIAN TIME: 8 HOURS

- **DUTY:** **GAS METAL ARC WELDING (GMAW) (BASIC)**
- **TASK:** Troubleshoot Equipment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to gas metal arc welding component identification;

B. Provide demonstrations related to shielding gas equipment and accessory component identification;

C. Provide demonstrations related to minor external repairs on gas metal arc welding equipment and accessories;

D. Provide demonstrations related to minor external repairs on shielding gas equipment and accessories;

E. Understand related terms and definitions; and,

F. Perform repair assignments when required.

INSTRUCTIONAL MATERIALS:

Student Workbook
Two written tests on safety and GMAW procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M5-HO1)
MASTER Handout No. 2 (WLD-M5-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students will complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of troubleshooting processes with GMAW equipment
- A class demonstration of effective troubleshooting
- A discussion on methods leading to an increase of skill and knowledge

PRESENTATION OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment

Student Activities:

A. Set up procedure for GMAW process and equipment

B. Perform Welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds

C. Perform welding in multiple positions

D. Describe the most common GMAW weldability problems

E. Illustrate GMAW filler metal classification by AWS standards

F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

G. Demonstrate ability to repair welds

H. Demonstrate ability to preheat weld area if necessary

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

Two examinations will be given in this module to determine student progress.

SUMMARY:

Troubleshooting means inspecting and finding causes of trouble or malfunctions. It requires conceptual and theoretical knowledge of the system, problem solving skills, and mechanical/electrical skills.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M6) dealing with describing AWS electrode classification system.

WLD-M5-HO1
Troubleshoot Equipment
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to gas metal arc welding component identification;
B. Provide demonstrations related to shielding gas equipment and accessory component identification;
C. Provide demonstrations related to minor external repairs on gas metal arc welding equipment and accessories;
D. Provide demonstrations related to minor external repairs on shielding gas equipment and accessories;
E. Understand related terms and definitions; and,
F. Perform repair assignments when required.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Perform Welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
C. Perform welding in multiple positions
D. Describe the most common GMAW weldability problems
E. Illustrate GMAW filler metal classification by AWS standards
F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System
G. Demonstrate ability to repair welds
H. Demonstrate ability to preheat weld area if necessary

WLD-M5-HO2
Troubleshoot Equipment
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

e. Weld the second pass with electrode centered at the bottom toe of the first pass
f. Weld the third pass with electrode centered at the top toe of the second pass
g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO_2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

Name: ______________________________ Date: ______________________

WLD-M5
Troubleshoot Equipment
Self-Assessment

Circle the best answer.

1. What polarity does MIG normally run on?
    - A. AC
    - B. Electrode Negative
    - C. Electrode Positive
    - D. Both A and C
    - E. None of the above

2. Spray MIG Welding is used to weld what thickness metal?
    - A. Thick
    - B. Thin

3. How do you change the amperage when MIG Welding?
    - A. Wire feed speed
    - B. Current setting
    - C. Voltage setting
    - D. None of the above

4. What does the gas do for MIG Welding?
    - A. Cleans the base metal
    - B. Burns and makes heat which helps melt the base metal
    - C. Forces the weld metal onto the base plate
    - D. Keeps air away from the molten weld pool
    - E. None of the above

5. Short Circuit MIG Welding is used to weld what thickness of metal?
    - A. Thick
    - B. It is not used with MIG
    - C. Thin
    - D. Thick aluminum only
    - E. None of the above

6. With MIG Welding, what technique is usually used?
    - A. Push
    - B. Pull
    - C. Whip
    - D. Spot
    - E. None of the above

7. Why is a spatter buildup on the inside of the nozzle harmful to a good weld?
   A. Stops the electrode
   B. Stops the gas
   C. Stops the polarity
   D. Causes too much voltage
   E. None of the above

8. What should the shielding gas be set at for MIG Welding?
   A. 5 ech
   B. 15 psi
   C. 30 psi
   D. 25 cfh
   E. 5 psi

9. What is ER 70S-3?
   A. Shielding gas
   B. Miller MIG Welder
   C. Lincoln Wire Feeder
   D. Electrode
   E. None of the above

10. In MIG welding, what does a flow meter do?
    A. Controls shielding gas flow
    B. Measures amperage
    C. Feeds wire electrode
    D. Voltage sensing device
    E. None of the above

11. In MIG welding, what shielding gas makes a rough looking weld with a large amount of spatter?
    A. 98% argon, 2% oxygen
    B. 90% argon, 10% Co2
    C. 100% argon
    D. 100% Co2
    E. Both A and B

12. In MIG welding, which shielding gas is used for spray transfer?
    A. 100% argon
    B. 100% Co2
    C. 75% argon, 25% Co2
    D. 95% argon, 5% oxygen
    E. All of the above
    F. None of the above

13. In MIG welding, what causes electrode stubbing?
    A. Wire feed too high
    B. Wire feed too low
    C. Voltage too high
    D. Voltage too low
    E. Both A and C
    F. None of the above

14. In MIG welding, how long is the stickout?
    A. 1/32”
    B. 3/16”
    C. 3/8”
    D. 3/4”
    E. 1”

15. In MIG welding sheet metal, how do you fill a large gap?
    A. Weave it in
    B. Whipping
    C. Pulse arc with trigger
    D. U-Weave
    E. Both C and D
    F. None of the above

16. In MIG welding, what is the purpose of the drive rolls?
    A. Moves the MIG gun
    B. Guides the MIG gun
    C. Feeds the electrode
    D. Wheels inside gun liner attached to flow meter
    E. None of the above

WLD-M6

WELDER SERIES

MASTER Technical Module No. WLD-M06

SUBJECT: WELDING TECHNICIAN TIME: 6 HOURS

- **DUTY:** **GAS METAL ARC WELDING (GMAW) (BASIC)**
- **TASK:** Describe AWS Electrode Classification System

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify GMAW Electrodes using AWS Classification System;
B. Identify compatibility of parent metals and electrodes; and,
C. Illustrate compatibility of parent metals and electrodes/wires by proper selection exercises.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on AWS Electrode Classification Systems
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M6-HO1)
MASTER Handout No. 2 (WLD-M6-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Standard Welding Code – Aluminum, ANSI/AWS D1.2-90, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students will complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the AWS Electrode Classification System
- A class demonstration of effective selection methods for compatibility
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment
D. Describe the most common GMAW weldability problems
E. Use GMAW filler metal classification by AWS standards
F. Select GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Select GMAW electrodes using AWS and Aluminum Association Classification methods
C. Perform welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
D. Perform welding in multiple positions
E. Demonstrate ability to repair welds
F. Demonstrate ability to preheat weld area if necessary

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

Examinations will be given in this module to determine student progress.

SUMMARY:

There are several AWS Specifications applicable to the gas metal arc welding (GMAW) process. The AWS is a good standard to use as a guideline. Other AWS Specifications are available for all of the electrodes and filler metals presently used in welding processes. There are two sections to each of the AWS Specifications. The first part is the actual Specification which provides all the legal data such as chemical compositions, electrode classifications, tests required, etc. This is where the designers and welding engineers select the correct filler metals for the weld joints. The second section of the specification is actually the "Description and Intended Use" information for each electrode classification, it's specific application defined, and special storage requirements. All electrodes are alloys of two or more elements. Some of the elements added to electrode core wire serve as alloying agents while others function as deoxidizers and scavengers of unwanted elements that could weaken the weld. Some alloying elements work as deoxidizers with one metal, and as an alloying element in another, and yet can be the prime metal in still other alloys.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M7) dealing with describing Aluminum Assoc. metal classification system for aluminum alloys.

WLD-M6-HO1

Describe AWS Electrode Classification System

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify GMAW Electrodes using AWS Classification System;
B. Identify compatibility of parent metals and electrodes; and,
C. Illustrate compatibility of parent metals and electrodes/wires by proper selection exercises.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment
D. Describe the most common GMAW weldability problems
E. Use GMAW filler metal classification by AWS standards
F. Select GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Select GMAW electrodes using AWS and Aluminum Association Classification methods
C. Perform welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
D. Perform welding in multiple positions
E. Demonstrate ability to repair welds
F. Demonstrate ability to preheat weld area if necessary

WLD-M6-HO2
Describe AWS Electrode Classification System
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

Name: ______________________________ Date: ______________________

WLD-M6

Describe AWS Electrode Classification System

Self-Assessment

Circle the best answer.

1. What polarity does MIG normally run on?
    - A. AC
    - B. Electrode Negative
    - C. Electrode Positive
    - D. Both A and C
    - E. None of the above

2. Spray MIG Welding is used to weld what thickness metal?
    - A. Thick
    - B. Thin

3. How do you change the amperage when MIG Welding?
    - A. Wire feed speed
    - B. Current setting
    - C. Voltage setting
    - D. None of the above

4. What does the gas do for MIG Welding?
    - A. Cleans the base metal
    - B. Burns and makes heat which helps melt the base metal
    - C. Forces the weld metal onto the base plate
    - D. Keeps air away from the molten weld pool
    - E. None of the above

5. Short Circuit MIG Welding is used to weld what thickness of metal?
    - A. Thick
    - B. It is not used with MIG
    - C. Thin
    - D. Thick aluminum only
    - E. None of the above

6. With MIG Welding, what technique is usually used?
    - A. Push
    - B. Pull
    - C. Whip
    - D. Spot
    - E. None of the above

7. Why is a spatter buildup on the inside of the nozzle harmful to a good weld?
   A. Stops the electrode
   B. Stops the gas
   C. Stops the polarity
   D. Causes too much voltage
   E. None of the above

8. What should the shielding gas be set at for MIG Welding?
   A. 5 ech
   B. 15 psi
   C. 30 psi
   D. 25 cfh
   E. 5 psi

9. What is ER 70S-3?
   A. Shielding gas
   B. Miller MIG Welder
   C. Lincoln Wire Feeder
   D. Electrode
   E. None of the above

10. In MIG welding, what does a flow meter do?
   A. Controls shielding gas flow
   B. Measures amperage
   C. Feeds wire electrode
   D. Voltage sensing device
   E. None of the above

11. In MIG welding, what shielding gas makes a rough looking weld with a large amount of spatter?
   A. 98% argon, 2% oxygen
   B. 90% argon, 10% Co2
   C. 100% argon
   D. 100% Co2
   E. Both A and B

12. In MIG welding, which shielding gas is used for spray transfer?
   A. 100% argon
   B. 100% Co2
   C. 75% argon, 25% Co2
   D. 95% argon, 5% oxygen
   E. All of the above
   F. None of the above

13. In MIG welding, what causes electrode stubbing?
- A. Wire feed too high
- B. Wire feed too low
- C. Voltage too high
- D. Voltage too low
- E. Both A and C
- F. None of the above

14. In MIG welding, how long is the stickout?
- A. 1/32"
- B. 3/16"
- C. 3/8"
- D. 3/4"
- E. 1"

15. In MIG welding sheet metal, how do you fill a large gap?
- A. Weave it in
- B. Whipping
- C. Pulse arc with trigger
- D. U-Weave
- E. Both C and D
- F. None of the above

16. In MIG welding, what is the purpose of the drive rolls?
- A. Moves the MIG gun
- B. Guides the MIG gun
- C. Feeds the electrode
- D. Wheels inside gun liner attached to flow meter
- E. None of the above

WELDER SERIES
MASTER Technical Module No. WLD-M07

SUBJECT: WELDING TECHNICIAN TIME: 6 HOURS

- **DUTY:** **GAS METAL ARC WELDING (GMAW) (BASIC)**
- **TASK:** Describe Aluminum Assoc. Metal Classification System for Aluminum Alloys

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Illustrate GMAW Filler Metal classifications by AWS standards; and,
B. Demonstrate knowledge of aluminum alloys by practice.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW procedures with aluminum
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M7-HO1)
MASTER Handout No. 2 (WLD-M7-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need for filler metal classifications as part of the welding process
- A class demonstration of effective GMAW techniques with aluminum
- A discussion on training activities resulting in an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment
D. Describe the most common GMAW weldability problems
E. Illustrate GMAW filler metal classification by AWS standards
F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

- A. Set up procedure for GMAW process and equipment
- B. Select compatibility filler metal or alloys
- C. Perform welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
- D. Perform welding in multiple positions
- E. Demonstrate ability to repair welds
- F. Demonstrate ability to preheat weld area if necessary

PRACTICAL APPLICATION:

The student will use GMAW with aluminum and compatibility alloys classified by AWS and the Aluminum Association Metal Classification System.

EVALUATION AND/OR VERIFICATION:

Examination will be given in this module to determine student progress. Practical exercises will be evaluated by student and instructor.

SUMMARY:

The metal classification system for aluminum alloys must be fully understood to insure that welds are performed, according to AWS standards, with these materials.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M8) dealing with describing most common weldability problems associated with aluminum and copper alloys.

WLD-M7-HO1

Describe Aluminum Assoc. Metal Classification System for Aluminum Alloys

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Illustrate GMAW Filler Metal classifications by AWS standards; and,

B. Demonstrate knowledge of aluminum alloys by practice.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment

B. Illustrate safety and preventive practices

C. Illustrate welding variables and adjustments to equipment

D. Describe the most common GMAW weldability problems

E. Illustrate GMAW filler metal classification by AWS standards

F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment

B. Select compatibility filler metal or alloys

C. Perform welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds

D. Perform welding in multiple positions

E. Demonstrate ability to repair welds

F. Demonstrate ability to preheat weld area if necessary

WLD-M7-HO2

Describe Aluminum Assoc. Metal Classification System for Aluminum Alloys

Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

Name: ______________________________ Date: ______________________

WLD-M7

Describe Aluminum Assoc. Metal Classification System for Aluminum Alloys

Self-Assessment

Circle the best answer.

1. What polarity does MIG normally run on?
   A. AC
   B. Electrode Negative
   C. Electrode Positive
   D. Both A and C
   E. None of the above

2. Spray MIG Welding is used to weld what thickness metal?
   A. Thick
   B. Thin

3. How do you change the amperage when MIG Welding?
   A. Wire feed speed
   B. Current setting
   C. Voltage setting
   D. None of the above

4. What does the gas do for MIG Welding?
   A. Cleans the base metal
   B. Burns and makes heat which helps melt the base metal
   C. Forces the weld metal onto the base plate
   D. Keeps air away from the molten weld pool
   E. None of the above

5. Short Circuit MIG Welding is used to weld what thickness of metal?
   A. Thick
   B. It is not used with MIG
   C. Thin
   D. Thick aluminum only
   E. None of the above

6. With MIG Welding, what technique is usually used?
   A. Push
   B. Pull
   C. Whip
   D. Spot
   E. None of the above

7. Why is a spatter buildup on the inside of the nozzle harmful to a good weld?
   - A. Stops the electrode
   - B. Stops the gas
   - C. Stops the polarity
   - D. Causes too much voltage
   - E. None of the above

8. What should the shielding gas be set at for MIG Welding?
   - A. 5 ech
   - B. 15 psi
   - C. 30 psi
   - D. 25 cfh
   - E. 5 psi

9. What is ER 70S-3?
   - A. Shielding gas
   - B. Miller MIG Welder
   - C. Lincoln Wire Feeder
   - D. Electrode
   - E. None of the above

10. In MIG welding, what does a flow meter do?
    - A. Controls shielding gas flow
    - B. Measures amperage
    - C. Feeds wire electrode
    - D. Voltage sensing device
    - E. None of the above

11. In MIG welding, what shielding gas makes a rough looking weld with a large amount of spatter?
    - A. 98% argon, 2% oxygen
    - B. 90% argon, 10% Co2
    - C. 100% argon
    - D. 100% Co2
    - E. Both A and B

12. In MIG welding, which shielding gas is used for spray transfer?
    - A. 100% argon
    - B. 100% Co2
    - C. 75% argon, 25% Co2
    - D. 95% argon, 5% oxygen
    - E. All of the above
    - F. None of the above

13. In MIG welding, what causes electrode stubbing?
    A. Wire feed too high
    B. Wire feed too low
    C. Voltage too high
    D. Voltage too low
    E. Both A and C
    F. None of the above

14. In MIG welding, how long is the stickout?
    A. 1/32”
    B. 3/16”
    C. 3/8”
    D. 3/4”
    E. 1”

15. In MIG welding sheet metal, how do you fill a large gap?
    A. Weave it in
    B. Whipping
    C. Pulse arc with trigger
    D. U-Weave
    E. Both C and D
    F. None of the above

16. In MIG welding, what is the purpose of the drive rolls?
    A. Moves the MIG gun
    B. Guides the MIG gun
    C. Feeds the electrode
    D. Wheels inside gun liner attached to flow meter
    E. None of the above

WELDER SERIES

MASTER Technical Module No. WLD-M08

SUBJECT: **WELDING TECHNICIAN** **TIME: 12 HOURS**

- **DUTY:** **GAS METAL ARC WELDING (GMAW) (BASIC)**
- **TASK:** Describe Most Common Weldability Problems Associated with Aluminum and Copper Alloys

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand filler metal compatibility associated with aluminum and copper; and,

B. Demonstrate knowledge of weldability by selection of materials and practice.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on Safety and GMAW Procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M8-HO1)
MASTER Handout No. 2 (WLD-M8-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need for filler metal compatibility
- A class discussion of appropriate references of effective welding techniques for aluminum and copper
- A discussion on quality welds

PRESENTATION OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment
D. Describe the most common GMAW weldability problems with aluminum and copper
E. Illustrate GMAW filler metal classification by AWS standards
F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Perform Welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
C. Perform welding in multiple positions
D. Demonstrate ability to repair welds
E. Demonstrate ability to preheat weld area if necessary

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible with aluminum and copper.

EVALUATION AND/OR VERIFICATION:

Two examinations will be given in this module to determine student progress.

SUMMARY:

Aluminum and copper alloys can present a number of weldability problems if filler metal compatibility is not insured.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M9) dealing with performing GMAW fillet and groove welds on T and butt joints on various metals in various positions.

WLD-M8-HO1
Describe Most Common Weldability Problems Associated With Aluminum and Copper Alloys
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand filler metal compatibility associated with aluminum and copper; and,

B. Demonstrate knowledge of weldability by selection of materials and practice.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment

B. Illustrate safety and preventive practices

C. Illustrate welding variables and adjustments to equipment

D. Describe the most common GMAW weldability problems with aluminum and copper

E. Illustrate GMAW filler metal classification by AWS standards

F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment

B. Perform Welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds

C. Perform welding in multiple positions

D. Demonstrate ability to repair welds

E. Demonstrate ability to preheat weld area if necessary

WLD-M8-HO2
Describe Most Common Weldability Problems Associated With Aluminum and Copper Alloys
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

6. Weld With GMAW Using Globular Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

Name: ______________________________ Date: ______________________

WLD-M8

Describe Most Common Weldability Problems Associated With Aluminum and Copper Alloys

Self-Assessment

Circle the best answer.

1. What polarity does MIG normally run on?
   A. AC
   B. Electrode Negative
   C. Electrode Positive
   D. Both A and C
   E. None of the above

2. Spray MIG Welding is used to weld what thickness metal?
   A. Thick
   B. Thin

3. How do you change the amperage when MIG Welding?
   A. Wire feed speed
   B. Current setting
   C. Voltage setting
   D. None of the above

4. What does the gas do for MIG Welding?
   A. Cleans the base metal
   B. Burns and makes heat which helps melt the base metal
   C. Forces the weld metal onto the base plate
   D. Keeps air away from the molten weld pool
   E. None of the above

5. Short Circuit MIG Welding is used to weld what thickness of metal?
   A. Thick
   B. It is not used with MIG
   C. Thin
   D. Thick aluminum only
   E. None of the above

6. With MIG Welding, what technique is usually used?
   A. Push
   B. Pull
   C. Whip
   D. Spot
   E. None of the above

7. Why is a spatter buildup on the inside of the nozzle harmful to a good weld?
   A. Stops the electrode
   B. Stops the gas
   C. Stops the polarity
   D. Causes too much voltage
   E. None of the above

8. What should the shielding gas be set at for MIG Welding?
   A. 5 ech
   B. 15 psi
   C. 30 psi
   D. 25 cfh
   E. 5 psi

9. What is ER 70S-3?
   A. Shielding gas
   B. Miller MIG Welder
   C. Lincoln Wire Feeder
   D. Electrode
   E. None of the above

10. In MIG welding, what does a flow meter do?
    A. Controls shielding gas flow
    B. Measures amperage
    C. Feeds wire electrode
    D. Voltage sensing device
    E. None of the above

11. In MIG welding, what shielding gas makes a rough looking weld with a large amount of spatter?
    A. 98% argon, 2% oxygen
    B. 90% argon, 10% Co2
    C. 100% argon
    D. 100% Co2
    E. Both A and B

12. In MIG welding, which shielding gas is used for spray transfer?
   A. 100% argon
   B. 100% Co2
   C. 75% argon, 25% Co2
   D. 95% argon, 5% oxygen
   E. All of the above
   F. None of the above

13. In MIG welding, what causes electrode stubbing?
   A. Wire feed too high
   B. Wire feed too low
   C. Voltage too high
   D. Voltage too low
   E. Both A and C
   F. None of the above

14 In MIG welding, how long is the stickout?
   A. 1/32"
   B. 3/16"
   C. 3/8"
   D. 3/4"
   E. 1"

15 In MIG welding sheet metal, how do you fill a large gap?
   A. Weave it in
   B. Whipping
   C. Pulse arc with trigger
   D. U-Weave
   E. Both C and D
   F. None of the above

16. In MIG welding, what is the purpose of the drive rolls?
   A. Moves the MIG gun
   B. Guides the MIG gun
   C. Feeds the electrode
   D. Wheels inside gun liner attached to flow meter
   E. None of the above

WLD-M9

WELDER SERIES

MASTER Technical Module No. WLD-M09

SUBJECT: **WELDING TECHNICIAN** **TIME: 15 HOURS**

- **DUTY:** **GAS METAL ARC WELDING (GMAW) (BASIC)**
- **TASK:** Perform GMAW Fillet and Groove Welds on T and Butt Joints Various Metals in Various Positions

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to gas metal arc welding equipment operations;
B. Provide instruction related to gas metal arc welding principles of operation;
C. Provide instruction related to common process variables for gas metal arc welding;
D. Provide training exercises related to gas metal arc welding equipment operation;
E. Provide training exercises related to starting and maintaining an arc on plain carbon steel;
F. Provide training exercises related to flat, multiple pass, multi-directional, surfacing welds, on plain carbon steel, using short circuit transfer, .035 or .045 diameter E70S-X electrodes and a CO_2 or 75% argon/25% CO_2 shielding gas;
G. Provide training exercises related to flat, multiple pass, multi-directional, surfacing welds, on plain carbon steel using spray transfer, .035 or .045 diameter E70S-X electrodes and an argon with shielding gas 2%-5% oxygen;
H. Observe trainee following safe arc welding practices;
I. Observe trainee operating gas metal arc welding equipment;
J. Visually inspect trainee's workmanship samples; and,
K. Develop and administer formative or diagnostic tests relevant to gas metal arc welding principles of operation and common process variables.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on GMAW procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories

Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M9-HO1)
MASTER Handout No. 2 (WLD-M9-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students will complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview on preparation for GMAW fillet and groove welds
- A class demonstration of effective welding techniques with shielding gases
- A discussion on best methods and techniques for GMAW applications

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventative practices
C. Discuss use of shielding gases for best results with specific applications
D. Illustrate welding variables and adjustments to equipment
E. Describe the most common GMAW weldability problems
F. Illustrate GMAW filler metal classification by AWS standards
G. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Select shielding gases
C. Perform welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
D. Perform welding in multiple positions
E. Demonstrate ability to repair welds
F. Demonstrate ability to preheat weld area if necessary

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

Two examinations will be given during this module to determine the progress of the class. Selection and use of shielding gases will be made in specific applications for best results.

SUMMARY:

Because of oxidizing effects, oxidation of oxygen or carbon dioxide to argon may cause porosity in some ferrous metals, as well as loss of alloying elements of chromium, vanadium, and aluminum (among others). Filler wires used with oxygen containing shielding gas require addition of dioxides to counteract the effects of oxygen.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M10) dealing with demonstrating aluminum GMAW flat horizontal, vertical and overhead.

WLD-M9-HO1
Perform GMAW Fillet and Groove Welds on T and Butt Joints On Various Metals in Various Positions
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to gas metal arc welding equipment operations;
B. Provide instruction related to gas metal arc welding principles of operation;
C. Provide instruction related to common process variables for gas metal arc welding;
D. Provide training exercises related to gas metal arc welding equipment operation;
E. Provide training exercises related to starting and maintaining an arc on plain carbon steel;
F. Provide training exercises related to flat, multiple pass, multi-directional, surfacing welds, on plain carbon steel, using short circuit transfer, .035 or .045 diameter E70S-X electrodes and a CO_2 or 75% argon/25% CO_2 shielding gas;
G. Provide training exercises related to flat, multiple pass, multi-directional, surfacing welds, on plain carbon steel using spray transfer, .035 or .045 diameter E70S-X electrodes and an argon with shielding gas 2%-5% oxygen;
H. Observe trainee following safe arc welding practices;
I. Observe trainee operating gas metal arc welding equipment;
J. Visually inspect trainee's workmanship samples; and,
K. Develop and administer formative or diagnostic tests relevant to gas metal arc welding principles of operation and common process variables.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventative practices
C. Discuss use of shielding gases for best results with specific applications
D. Illustrate welding variables and adjustments to equipment
E. Describe the most common GMAW weldability problems
F. Illustrate GMAW filler metal classification by AWS standards
G. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Select shielding gases

C. Perform welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
D. Perform welding in multiple positions
E. Demonstrate ability to repair welds
F. Demonstrate ability to preheat weld area if necessary

WLD-M9-HO2
Perform GMAW Fillet and Groove Welds on T and Butt Joints On Various Metals in Various Positions
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   - a. Install adapter for particular brand of wire feeder
   - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   - c. Screw on gas defuser and tighten allen screw
   - d. Install contact tip
   - e. Install gas nozzle
   - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   - a. Compare and contrast constant current and constant voltage power sources
   - b. List effects of inductance on circuit
   - c. List effects of pinch effect
3. Shielding Gas Application
   - a. List arc characteristics caused by welding with 100% carbon dioxide
   - b. List arc characteristics caused by welding with 100% argon
   - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness

6. Weld With GMAW Using Globular Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

e. Weld the second pass with electrode centered at the bottom toe of the first pass
f. Weld the third pass with electrode centered at the top toe of the second pass
g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

Name: ______________________________ Date: ______________________

WLD-M9

Perform GMAW Fillet and Groove Welds on T and Butt Joints On Various Metals in Various Positions

Self-Assessment

Circle the best answer.

1. What polarity does MIG normally run on?
   A. AC
   B. Electrode Negative
   C. Electrode Positive
   D. Both A and C
   E. None of the above

2. Spray MIG Welding is used to weld what thickness metal?
   A. Thick
   B. Thin

3. How do you change the amperage when MIG Welding?
   A. Wire feed speed
   B. Current setting
   C. Voltage setting
   D. None of the above

4. What does the gas do for MIG Welding?
   A. Cleans the base metal
   B. Burns and makes heat which helps melt the base metal
   C. Forces the weld metal onto the base plate
   D. Keeps air away from the molten weld pool
   E. None of the above

5. Short Circuit MIG Welding is used to weld what thickness of metal?
   A. Thick
   B. It is not used with MIG
   C. Thin
   D. Thick aluminum only
   E. None of the above

6. With MIG Welding, what technique is usually used?
   A. Push
   B. Pull
   C. Whip
   D. Spot
   E. None of the above

7. Why is a spatter buildup on the inside of the nozzle harmful to a good weld?
   A. Stops the electrode
   B. Stops the gas
   C. Stops the polarity
   D. Causes too much voltage
   E. None of the above

8. What should the shielding gas be set at for MIG Welding?
   A. 5 ech
   B. 15 psi
   C. 30 psi
   D. 25 cfh
   E. 5 psi

9. What is ER 70S-3?
   A. Shielding gas
   B. Miller MIG Welder
   C. Lincoln Wire Feeder
   D. Electrode
   E. None of the above

10. In MIG welding, what does a flow meter do?
   A. Controls shielding gas flow
   B. Measures amperage
   C. Feeds wire electrode
   D. Voltage sensing device
   E. None of the above

11. In MIG welding, what shielding gas makes a rough looking weld with a large amount of spatter?
   A. 98% argon, 2% oxygen
   B. 90% argon, 10% Co2
   C. 100% argon
   D. 100% Co2
   E. Both A and B

12. In MIG welding, which shielding gas is used for spray transfer?
   A. 100% argon
   B. 100% Co2
   C. 75% argon, 25% Co2
   D. 95% argon, 5% oxygen
   E. All of the above
   F. None of the above

13. In MIG welding, what causes electrode stubbing?
   A. Wire feed too high
   B. Wire feed too low
   C. Voltage too high
   D. Voltage too low
   E. Both A and C
   F. None of the above

14. In MIG welding, how long is the stickout?
   A. 1/32"
   B. 3/16"
   C. 3/8"
   D. 3/4"
   E. 1"

15. In MIG welding sheet metal, how do you fill a large gap?
   A. Weave it in
   B. Whipping
   C. Pulse arc with trigger
   D. U-Weave
   E. Both C and D
   F. None of the above

16. In MIG welding, what is the purpose of the drive rolls?
   A. Moves the MIG gun
   B. Guides the MIG gun
   C. Feeds the electrode
   D. Wheels inside gun liner attached to flow meter
   E. None of the above

WELDER SERIES

MASTER Technical Module No. WLD-M10

SUBJECT: **WELDING TECHNICIAN** **TIME: 12 HOURS**

- **DUTY:** GAS METAL ARC WELDING (GMAW) (BASIC)
- **TASK:** Demonstrate Aluminum GMAW Flat, Horizontal, Vertical and Overhead

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand spray transfer process on GMAW aluminum alloys.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on aluminum GMAW welding procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M10-HO1)
MASTER Handout No. 2 (WLD-M10-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of GMAW aluminum welding
- A class demonstration of effective welding with aluminum
- A discussion on special techniques for vertical and overhead positions

PRESENTATION OUTLINE:

Instructional Topics:

A. **Identify the type of equipment to be used, and the differences of equipment**
B. **Illustrate safety and preventive practices**
C. **Illustrate welding variables and adjustments to equipment**
D. **Describe the most common GMAW weldability problems**
E. **Illustrate GMAW filler metal classification by AWS standards**
F. **Illustrate GMAW filler metal by Aluminum Association Metal Classification System**

Student Activities:

A. **Set up procedure for GMAW process and equipment**
B. **Perform selection of shielding gases and filler wire**
C. **Perform welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds**
D. **Perform welding in multiple positions**
E. **Demonstrate ability to repair welds**

F. Demonstrate ability to preheat weld area if necessary

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

Two written examinations will be given in this module to determine student progress.

Practical exercises will be evaluated by the student and the instructor.

SUMMARY:

Metal is generally deposited either by spray transfer or by globular transfer spray transfer (usually more desirable) produces relatively deep penetration at the center of the bead and shallow penetration at the edges; globular transfer produces a broader and more shallow penetration pattern.

Shape of a weld bead and penetration pattern are determined by metal transfer characteristics which are affected by the shielding gas, which protects the molten metal from contamination by oxygen and nitrogen in the atmosphere.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M11) dealing with describing GMAW filler wires.

WLD-M10-HO1

Demonstrate Aluminum GMAW Flat, Horizontal, Vertical and Overhead

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand spray transfer process on GMAW aluminum alloys.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment
D. Describe the most common GMAW weldability problems
E. Illustrate GMAW filler metal classification by AWS standards
F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Perform selection of shielding gases and filler wire
C. Perform welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
D. Perform welding in multiple positions
E. Demonstrate ability to repair welds
F. Demonstrate ability to preheat weld area if necessary

WLD-M10-HO2
Demonstrate Aluminum GMAW Flat, Horizontal, Vertical and Overhead
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

Name: ______________________________ Date: ______________________

WLD-M10
Demonstrate Aluminum GMAW Flat, Horizontal, Vertical and Overhead
Self-Assessment

Circle the best answer.

1. What polarity does MIG normally run on?
   - A. AC
   - B. Electrode Negative
   - C. Electrode Positive
   - D. Both A and C
   - E. None of the above

2. Spray MIG Welding is used to weld what thickness metal?
   - A. Thick
   - B. Thin

3. How do you change the amperage when MIG Welding?
   - A. Wire feed speed
   - B. Current setting
   - C. Voltage setting
   - D. None of the above

4. What does the gas do for MIG Welding?
   - A. Cleans the base metal
   - B. Burns and makes heat which helps melt the base metal
   - C. Forces the weld metal onto the base plate
   - D. Keeps air away from the molten weld pool
   - E. None of the above

5. Short Circuit MIG Welding is used to weld what thickness of metal?
   - A. Thick
   - B. It is not used with MIG
   - C. Thin
   - D. Thick aluminum only
   - E. None of the above

6. With MIG Welding, what technique is usually used?
   - A. Push
   - B. Pull
   - C. Whip
   - D. Spot
   - E. None of the above

7. Why is a spatter buildup on the inside of the nozzle harmful to a good weld?
   A. Stops the electrode
   B. Stops the gas
   C. Stops the polarity
   D. Causes too much voltage
   E. None of the above

8. What should the shielding gas be set at for MIG Welding?
   A. 5 ech
   B. 15 psi
   C. 30 psi
   D. 25 cfh
   E. 5 psi

9. What is ER 70S-3?
   A. Shielding gas
   B. Miller MIG Welder
   C. Lincoln Wire Feeder
   D. Electrode
   E. None of the above

10. In MIG welding, what does a flow meter do?
   A. Controls shielding gas flow
   B. Measures amperage
   C. Feeds wire electrode
   D. Voltage sensing device
   E. None of the above

11. In MIG welding, what shielding gas makes a rough looking weld with a large amount of spatter?
   A. 98% argon, 2% oxygen
   B. 90% argon, 10% Co2
   C. 100% argon
   D. 100% Co2
   E. Both A and B

12. In MIG welding, which shielding gas is used for spray transfer?
   A. 100% argon
   B. 100% Co2
   C. 75% argon, 25% Co2
   D. 95% argon, 5% oxygen
   E. All of the above
   F. None of the above

13. In MIG welding, what causes electrode stubbing?
    A. Wire feed too high
    B. Wire feed too low
    C. Voltage too high
    D. Voltage too low
    E. Both A and C
    F. None of the above

14. In MIG welding, how long is the stickout?
    A. 1/32”
    B. 3/16”
    C. 3/8”
    D. 3/4”
    E. 1”

15. In MIG welding sheet metal, how do you fill a large gap?
    A. Weave it in
    B. Whipping
    C. Pulse arc with trigger
    D. U-Weave
    E. Both C and D
    F. None of the above

16. In MIG welding, what is the purpose of the drive rolls?
    A. Moves the MIG gun
    B. Guides the MIG gun
    C. Feeds the electrode
    D. Wheels inside gun liner attached to flow meter
    E. None of the above

WLD-M11

WELDER SERIES

MASTER Technical Module No. WLD-M11

SUBJECT: WELDING TECHNICIAN TIME: 3 HOURS

- **DUTY:** **GAS METAL ARC WELDING (GMAW) (BASIC)**
- **TASK:** Describe GMAW Filler Wires

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand compatibility of filler metal to base metal; and,
B. Understand AWS Electrode Classification System for GMAW.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on AWS Electrode Classification System
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M11-HO1)
MASTER Handout No. 2 (WLD-M11-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding: Principles and Practices, Sacks, Raymond, New York: Glencoe, McGraw-Hill, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the AWS Electrode Classification System
- A discussion of sources and references of information such as the AWS A5.18-79, "Chemical - Composition Requirements for Gas Metal Arc Welding - Electrode."

PRESENTATION OUTLINE:

Instructional Topics:

A. Identify the type of electrode and classification markings
B. Illustrate the significance of classification numbers
C. Present mechanical property requirements
D. Present impact property requirements
E. Present chemical composition requirement

F. Describe principles of use and storage of rod and filler wire
G. Describe the most common GMAW weldability problems associated with electrodes and filler wire
H. Illustrate GMAW filler metal classification by AWS standards/classification charts
I. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Discuss GMAW filler wires, fluxes, and GMAW applications
B. Perform classification exercises, given weld specifications from the instructor
C. Discuss the importance of mechanical properties, impact properties, and chemical composition of filler wires to the welding process

---

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

Emphasis is on specific applications that involve selection of filler metal and fluxes with GMAW.

EVALUATION AND/OR VERIFICATION:

Written examinations will be given in this module to determine student progress.

SUMMARY:

Welder improve their techniques and methods with knowledge of AWS standards and specifications, to include electrode classification systems. Originally a color identification system was developed by the National Electrical Manufacturers Association in conjunction with the American Welding Society to identify electrode classification. This was a system of color markings. In 1964, AWS required the classification numbers be imprinted on the covering. Since some sizes are too small to be imprinted, color code is still used for some electrodes.

Filler metal electrodes are generally classified by chemical composition, mechanical properties, type of shielding gas, corrosion resistance, usability (current, polarity, welding position, etc.). Some are also classified on the basis of simple or multiple pass operation. Fluxes are classified separately on the basis of mechanical properties. Welders should be aware of the need for compatibility studies, using the wide resources available for this purpose.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M12) dealing with demonstrating ability to repair welds.

WLD-M11-HO1
Describe GMAW Filler Wires
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- A. Understand compatibility of filler metal to base metal; and,
- B. Understand AWS Electrode Classification System for GMAW.

MODULE OUTLINE:

Instructional Topics:
- A. Identify the type of electrode and classification markings
- B. Illustrate the significance of classification numbers
- C. Present mechanical property requirements
- D. Present impact property requirements
- E. Present chemical composition requirement
- F. Describe principles of use and storage of rod and filler wire
- G. Describe the most common GMAW weldability problems associated with electrodes and filler wire
- H. Illustrate GMAW filler metal classification by AWS standards/classification charts
- I. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:
- A. Discuss GMAW filler wires, fluxes, and GMAW applications
- B. Perform classification exercises, given weld specifications from the instructor
- C. Discuss the importance of mechanical properties, impact properties, and chemical composition of filler wires to the welding process

WLD-M11-HO2
Describe GMAW Filler Wires
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

Name: ______________________________ Date: ______________________

WLD-M11
Describe GMAW Filler Wires
Self-Assessment

Circle the best answer.

1. What polarity does MIG normally run on?
   - A. AC
   - B. Electrode Negative
   - C. Electrode Positive
   - D. Both A and C
   - E. None of the above

2. Spray MIG Welding is used to weld what thickness metal?
   - A. Thick
   - B. Thin

3. How do you change the amperage when MIG Welding?
   - A. Wire feed speed
   - B. Current setting
   - C. Voltage setting
   - D. None of the above

4. What does the gas do for MIG Welding?
   - A. Cleans the base metal
   - B. Burns and makes heat which helps melt the base metal
   - C. Forces the weld metal onto the base plate
   - D. Keeps air away from the molten weld pool
   - E. None of the above

5. Short Circuit MIG Welding is used to weld what thickness of metal?
   - A. Thick
   - B. It is not used with MIG
   - C. Thin
   - D. Thick aluminum only
   - E. None of the above

6. With MIG Welding, what technique is usually used?
   - A. Push
   - B. Pull
   - C. Whip
   - D. Spot
   - E. None of the above

7. Why is a spatter buildup on the inside of the nozzle harmful to a good weld?
   - A. Stops the electrode
   - B. Stops the gas
   - C. Stops the polarity
   - D. Causes too much voltage
   - E. None of the above

8. What should the shielding gas be set at for MIG Welding?
   - A. 5 ech
   - B. 15 psi
   - C. 30 psi
   - D. 25 cfh
   - E. 5 psi

9. What is ER 70S-3?
   - A. Shielding gas
   - B. Miller MIG Welder
   - C. Lincoln Wire Feeder
   - D. Electrode
   - E. None of the above

10. In MIG welding, what does a flow meter do?
   - A. Controls shielding gas flow
   - B. Measures amperage
   - C. Feeds wire electrode
   - D. Voltage sensing device
   - E. None of the above

11. In MIG welding, what shielding gas makes a rough looking weld with a large amount of spatter?
   - A. 98% argon, 2% oxygen
   - B. 90% argon, 10% Co2
   - C. 100% argon
   - D. 100% Co2
   - E. Both A and B

12. In MIG welding, which shielding gas is used for spray transfer?
   - A. 100% argon
   - B. 100% Co2
   - C. 75% argon, 25% Co2
   - D. 95% argon, 5% oxygen
   - E. All of the above
   - F. None of the above

13. In MIG welding, what causes electrode stubbing?
    A. Wire feed too high
    B. Wire feed too low
    C. Voltage too high
    D. Voltage too low
    E. Both A and C
    F. None of the above

14. In MIG welding, how long is the stickout?
    A. 1/32"
    B. 3/16"
    C. 3/8"
    D. 3/4"
    E. 1"

15. In MIG welding sheet metal, how do you fill a large gap?
    A. Weave it in
    B. Whipping
    C. Pulse arc with trigger
    D. U-Weave
    E. Both C and D
    F. None of the above

16. In MIG welding, what is the purpose of the drive rolls?
    A. Moves the MIG gun
    B. Guides the MIG gun
    C. Feeds the electrode
    D. Wheels inside gun liner attached to flow meter
    E. None of the above

WELDER SERIES

MASTER Technical Module No. WLD-M12

SUBJECT: WELDING TECHNICIAN TIME: 6 HOURS

- **DUTY:** **GAS METAL ARC WELDING (GMAW) (BASIC)**
- **TASK:** Demonstrate Ability to Repair Welds

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the need to repair welds;
B. Understand the removal of discontinuity; and,
C. Repair by re-weld.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on safety and GMAW procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M12-HO1)
MASTER Handout No. 2 (WLD-M12-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need for repair of welds
- A class demonstration of effective techniques in re-welding

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment
D. Describe the most common GMAW weldability problems
E. Illustrate GMAW filler metal classification by AWS standards
F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A, Set up procedure for GMAW process and equipment
B. Perform welds specified by instructor with various metals and filler wire using single and multi-pass welds
C. Perform welding in multiple positions
D. Determine the defect or non-conformity that can be corrected by re-weld
E. Demonstrate ability to repair welds
F. Demonstrate ability to preheat weld area if necessary

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible. Student will recognize the defect or non-conformity that can be repaired by re-weld, and those that cannot be corrected.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Re-welds will be tested following performance of work.

SUMMARY:

The removal of weld metal or portions of the base metal may be done by mechanical means. The remaining base metal must not be undercut. Unacceptable portions of the weld shall be removed without substantial removal of base metal. Metal added shall be deposited by a qualified welder with filler of the same composition in accordance with an approved welding procedure.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M13) dealing with demonstrating machine adjustments (voltage, amps, wire speed).

WLD-M12-HO1
Demonstrate Ability to Repair Welds
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the need to repair welds;
B. Understand the removal of discontinuity; and,
C. Repair by re-weld.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment
D. Describe the most common GMAW weldability problems
E. Illustrate GMAW filler metal classification by AWS standards
F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Perform welds specified by instructor with various metals and filler wire using single and multi-pass welds
C. Perform welding in multiple positions
D. Determine the defect or non-conformity that can be corrected by re-weld
E. Demonstrate ability to repair welds
F. Demonstrate ability to preheat weld area if necessary

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   - a Inspect area for safety
   - b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c Adjust the welding parameters for this task
   - d Tack a T joint using GMAW
   - e Weld 1/4" fillet welds in 2F position using string bead technique
   - f Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   - g Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   - a Inspect area for safety
   - b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c Adjust the welding parameters for this task
   - d Tack a T joint using GMAW
   - e Weld the second pass with electrode centered at the bottom toe of the first pass
   - f Weld the third pass with electrode centered at the top toe of the second pass
   - g Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   - a Inspect area for safety
   - b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

Name: ______________________ Date: ______________________

WLD-M12
Demonstrate Ability to Repair Welds
Self-Assessment

Circle the best answer.

1. What polarity does MIG normally run on?
   A. AC
   B. Electrode Negative
   C. Electrode Positive
   D. Both A and C
   E. None of the above

2. Spray MIG Welding is used to weld what thickness metal?
   A. Thick
   B. Thin

3. How do you change the amperage when MIG Welding?
   A. Wire feed speed
   B. Current setting
   C. Voltage setting
   D. None of the above

4. What does the gas do for MIG Welding?
   A. Cleans the base metal
   B. Burns and makes heat which helps melt the base metal
   C. Forces the weld metal onto the base plate
   D. Keeps air away from the molten weld pool
   E. None of the above

5. Short Circuit MIG Welding is used to weld what thickness of metal?
   A. Thick
   B. It is not used with MIG
   C. Thin
   D. Thick aluminum only
   E. None of the above

6. With MIG Welding, what technique is usually used?
   A. Push
   B. Pull
   C. Whip
   D. Spot
   E. None of the above

7. Why is a spatter buildup on the inside of the nozzle harmful to a good weld?
   - A. Stops the electrode
   - B. Stops the gas
   - C. Stops the polarity
   - D. Causes too much voltage
   - E. None of the above

8. What should the shielding gas be set at for MIG Welding?
   - A. 5 ech
   - B. 15 psi
   - C. 30 psi
   - D. 25 cfh
   - E. 5 psi

9. What is ER 70S-3?
   - A. Shielding gas
   - B. Miller MIG Welder
   - C. Lincoln Wire Feeder
   - D. Electrode
   - E. None of the above

10. In MIG welding, what does a flow meter do?
   - A. Controls shielding gas flow
   - B. Measures amperage
   - C. Feeds wire electrode
   - D. Voltage sensing device
   - E. None of the above

11. In MIG welding, what shielding gas makes a rough looking weld with a large amount of spatter?
   - A. 98% argon, 2% oxygen
   - B. 90% argon, 10% Co2
   - C. 100% argon
   - D. 100% Co2
   - E. Both A and B

12. In MIG welding, which shielding gas is used for spray transfer?
   - A. 100% argon
   - B. 100% Co2
   - C. 75% argon, 25% Co2
   - D. 95% argon, 5% oxygen
   - E. All of the above
   - F. None of the above

13. In MIG welding, what causes electrode stubbing?
    A. Wire feed too high
    B. Wire feed too low
    C. Voltage too high
    D. Voltage too low
    E. Both A and C
    F. None of the above

14. In MIG welding, how long is the stickout?
    A. 1/32"
    B. 3/16"
    C. 3/8"
    D. 3/4"
    E. 1"

15. In MIG welding sheet metal, how do you fill a large gap?
    A. Weave it in
    B. Whipping
    C. Pulse arc with trigger
    D. U-Weave
    E. Both C and D
    F. None of the above

16. In MIG welding, what is the purpose of the drive rolls?
    A. Moves the MIG gun
    B. Guides the MIG gun
    C. Feeds the electrode
    D. Wheels inside gun liner attached to flow meter
    E. None of the above

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

	Duties	Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with coworkers and supervisors						
E	Work as a Team	E-1 Understand the roles of coworkers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welder identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

1660

1670

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES

MASTER Technical Module No. WLD-M13

SUBJECT: **WELDING TECHNICIAN** **TIME: 8 HOURS**

- **DUTY:** **GMAW SHORT CIRCUIT TRANSFER (INTERMEDIATE)**
- **TASK:** Demonstrate Machine Adjustments (Voltage, Amps, Wire Speed)

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the effects of variables on weld quality; and,

B. Adjust GMAW equipment to improve weld quality.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on safety and machine adjustment procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M13-HO1)
MASTER Handout No. 2 (WLD-M13-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition

Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition

Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of GMAW short circuit transfer methods
- A demonstration of effective machine adjustments

PRESENTATION OUTLINE:

Instructor Topics:

A. Describe SMAW short circuit transfer methods
B. Emphasizes the principles involved in of GMAW machine adjustments
C. Demonstrate knowledge of voltage and amperes and their effects on welding outcomes
D. Demonstrate uses of wire and wire speed

E. Demonstrate knowledge of the proper application of welding skills
F. Identify polarity requirements using GMAW short circuit transfer on various metals
G. Increase knowledge of current industry standards and techniques
H. Identify welding variables and their effects on weld quality
I. Identify the AISI steel classification system
J. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Discuss GMAW short circuit transfer methods
B. Set machine adjustments to approved values for welding procedure
C. Preheat weld surface
D. Adjust wire feeder mechanism, as appropriate
E. Perform single pass and multi-pass welds
F. Perform welds in four positions
G. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience with practice in setting the two basic controls (open circuit voltage and wire feed speed) and understanding the function of current limiting slope control.

EVALUATION AND/OR VERIFICATION:

Two examinations will be given during this module to determine the progress of the class.

SUMMARY:

GMAW or "MIG" equipment is more complex and requires detailed setup, verification, and adjustment procedures. The GMAW process requires four major pieces of equipment. These are: power supply, wire feed-unit, welding gun, and a gas supply. The power supply, providing constant DC voltage, offers constant arc voltage output by regulating current and wire feed speed. Current increases or decreases automatically to match electrode melt rate to wire feed rate. Machine power configuration is DECP. Many constant power machines have a current limiting device called slope control, that changes (manually or automatically) the slope of the power source volt-amp output curve.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M14) dealing with initiating welding process.

WLD-M13-HO1

Demonstrate Machine Adjustments (Voltage, Amps, Wire Speed)

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the effects of variables on weld quality; and,
B. Adjust GMAW equipment to improve weld quality.

MODULE OUTLINE:

Instructor Topics:

A. Describe SMAW short circuit transfer methods
B. Emphasizes the principles involved in of GMAW machine adjustments
C. Demonstrate knowledge of voltage and amperes and their effects on welding outcomes
D. Demonstrate uses of wire and wire speed
E. Demonstrate knowledge of the proper application of welding skills
F. Identify polarity requirements using GMAW short circuit transfer on various metals
G. Increase knowledge of current industry standards and techniques
H. Identify welding variables and their effects on weld quality
I. Identify the AISI steel classification system
J. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Discuss GMAW short circuit transfer methods
B. Set machine adjustments to approved values for welding procedure
C. Preheat weld surface
D. Adjust wire feeder mechanism, as appropriate
E. Perform single pass and multi-pass welds
F. Perform welds in four positions
G. Make adjustments to improve weld quality

WLD-M13-HO2

Demonstrate Machine Adjustments (Voltage, Amps, Wire Speed)

Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld 1/4" fillet welds in 2F position using string bead technique
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   - g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M14

SUBJECT: **WELDING TECHNICIAN** **TIME: 15 HOURS**

- **DUTY:** **GMAW SHORT CIRCUIT TRANSFER (INTERMEDIATE)**
- **TASK:** Initiate Welding Process

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand codes and specifications given to produce a desired weld;
B. Understand welding techniques necessary to produce a desired weld; and,
C. Understand principles and use of short circuit transfer.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW short circuit transfer
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M14-HO1)
MASTER Handout No. 2 (WLD-M14-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition

Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition

Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview on codes and specifications
- A class demonstration of effective GMAW techniques with short circuit transfer
- A discussion on methods leading to optimum quality welds

PRESENTATION OUTLINE:

Instructor Topics:

A. Discuss applications for GMAW short circuit transfer methods
B. Emphasizes the principles involved in the operating of GMAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints

E. Demonstrate knowledge of codes and specifications
F. Demonstrate knowledge of the proper application of welding skills
G Demonstrate knowledge of adequate preparation of welding surfaces
H. Increase skill level to pass certification tests offered by an employer
I. Prepare butt joints, and tee joints, for welding
J. Increase knowledge of current industry standards and techniques
G. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
L. Explain short circuit transfer events of contact, melting, separation, flattening, and recontact
M. Identify polarity requirements using GMAW short circuit transfer on various metals
N. Demonstrate preheat and how to maintain desired temperature
O. Identify welding variables and their effects on weld quality
P. Identify the AISI steel classification system
Q. Match GMAW electrodes to an appropriate base metal

Student Activities:
A. Discuss principles and use of short circuit transfer
B. Preheat weld surface
C. Perform welds in four positions
D. Use approved welding technique
E. Perform single pass and multi-pass welds
F. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience with GMAW short circuit transfer.

EVALUATION AND/OR VERIFICATION:

Examinations will be given during this module to determine the progress of the class.

Instructor will monitor and coach the student in safe operation of the equipment.

SUMMARY:

Short-circuit transfer is the slowest of GMAW metal transfer methods, but its major advantage is low heat input, making it useful in welding thin sections, and welding in all positions.

When the electrode touches base metal, a short circuit is created, and the high level of current produces heat to melt a portion of the electrode.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M15) dealing with performing weld sequence.

WLD-M14-HO1
Initiate Welding Process
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand codes and specifications given to produce a desired weld;
B. Understand welding techniques necessary to produce a desired weld; and,
C. Understand principles and use of short circuit transfer.

MODULE OUTLINE:

Instructor Topics:

A. Discuss applications for GMAW short circuit transfer methods
B. Emphasizes the principles involved in the operating of GMAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of codes and specifications
F. Demonstrate knowledge of the proper application of welding skills
G. Demonstrate knowledge of adequate preparation of welding surfaces
H. Increase skill level to pass certification tests offered by an employer
I. Prepare butt joints, and tee joints, for welding
J. Increase knowledge of current industry standards and techniques
G. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
L. Explain short circuit transfer events of contact, melting, separation, flattening, and recontact
M. Identify polarity requirements using GMAW short circuit transfer on various metals
N. Demonstrate preheat and how to maintain desired temperature
O. Identify welding variables and their effects on weld quality
P. Identify the AISI steel classification system
Q. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Discuss principles and use of short circuit transfer
B. Preheat weld surface
C. Perform welds in four positions
D. Use approved welding technique
E. Perform single pass and multi-pass welds
F. Make adjustments to improve weld quality

WLD-M14-HO2
Initiate Welding Process
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld 1/4" fillet welds in 2F position using string bead technique
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   - g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M15

SUBJECT: WELDING TECHNICIAN **TIME:** 10 HOURS

- **DUTY:** GMAW SHORT CIRCUIT TRANSFER (INTERMEDIATE)
- **TASK:** Perform Weld Sequence

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand adequate machine adjustments; and,
B. Perform welds in various positions.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW short circuit transfer and weld sequencing
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M15-HO1)
MASTER Handout No. 2 (WLD-M15-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of GMAW short circuit transfer
- A class demonstration of effective welding techniques and advantages of GMAW
- A discussion on weld sequence

PRESENTATION OUTLINE:

Instructor Topics:

A. Present the advantages and possible disadvantages of use of GMAW short circuit transfer methods for comparable applications.
B. Emphasizes the principles involved in the operating of GMAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Increase skill level to pass certification tests offered by an employer

H. Prepare butt joints, and tee joints, for welding
I. Increase knowledge of current industry standards and techniques
J. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
K. Identify polarity requirements using GMAW short circuit transfer on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Discuss advantages and possible disadvantages of the short circuit methods
B. Select shielding gas
C. Preheat weld surface
D. Perform welds in four positions
E. Use approved welding technique
F. Perform single pass welds with thinner metals and multi-pass welds with thicker metals
G. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

Examinations will be given during this module to determine the progress of the class. Welds will be inspected for compliance with AWS standards by the student and the instructor.

SUMMARY:

Short circuit transfer is a unique method because the electrode metal does not flow across the arc gap, but is deposited directly into the weld puddles. The short circuit method of metal transfer is designed primarily for welding steel materials 1/4" thick or less. The shielding gas maybe either welding grade carbon dioxide (CO_2) or an argon (CO_2) gas mixture.

Solid electrode wires for short circuit transfer are classified in the AWS Specification AS-18 for carbon steel and AS-28 for low alloy steels. Filler metal selection should be based on requirements of the specific application and the shielding gas.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M16) dealing with controlling weld technique.

WLD-M15-HO-1
Perform Weld Sequence
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand adequate machine adjustments; and,

B. Perform welds in various positions.

MODULE OUTLINE:

Instructor Topics:

A. Present the advantages and possible disadvantages of use of GMAW short circuit transfer methods for comparable applications.

B. Emphasizes the principles involved in the operating of GMAW equipment

C. Demonstrate knowledge of joint design and welding terms

D. Demonstrate ability to interpret drawings and blueprints

E. Demonstrate knowledge of the proper application of welding skills

F. Demonstrate knowledge of adequate preparation of welding surfaces

G. Increase skill level to pass certification tests offered by an employer

H. Prepare butt joints, and tee joints, for welding

I. Increase knowledge of current industry standards and techniques

J. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions

K. Identify polarity requirements using GMAW short circuit transfer on various metals

L. Demonstrate preheat and how to maintain desired temperature

M. Identify welding variables and their effects on weld quality

N. Identify the AISI steel classification system

O. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Discuss advantages and possible disadvantages of the short circuit methods

B. Select shielding gas

C. Preheat weld surface

D. Perform welds in four positions

E. Use approved welding technique

F. Perform single pass welds with thinner metals and multi-pass welds with thicker metals

G. Make adjustments to improve weld quality

WLD-M15-HO2
Perform Weld Sequence
·Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

- a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
- b. Choose the correct electrode for given material and applications both type and size
- c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    - a Inspect area for safety
    - b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c Adjust the welding parameters for this task
    - d Tack a T joint using GMAW
    - e Weld 1/4" fillet welds in 2F position using string bead technique
    - f Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    - g Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    - a Inspect area for safety
    - b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c Adjust the welding parameters for this task
    - d Tack a T joint using GMAW
    - e Weld the second pass with electrode centered at the bottom toe of the first pass
    - f Weld the third pass with electrode centered at the top toe of the second pass
    - g Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    - a Inspect area for safety
    - b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c Adjust the welding parameters for this task
    - d Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M16

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **GMAW SHORT CIRCUIT TRANSFER (INTERMEDIATE)**
- **TASK:** Control Weld Technique

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand weld requirements; and,
B. Understand weld techniques to produce specific welds.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on techniques to control welds in GMAW short circuit transfer
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M16-HO1)
MASTER Handout No. 2 (WLD-M16-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need to develop and control weld techniques
- A class demonstration of effective welding techniques in various positions
- A discussion on methods leading to an increase of skill in use of welding techniques

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of GMAW equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Increase skill level to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding

H. Increase knowledge of current industry standards and techniques
I. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using GMAW short circuit transfer on various metals
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use approved welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible. Because each welding task may be somewhat unique, it takes practice to recognize the before, during, and after-weld conditions that will yield the best possible weld. Also, if a joint is being welded in vertical or overhead positions slight variations in current and feed speed may improve weld quality and reduce metal run-out.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

Basic variables that must be controlled by the student are the gun angle relative to the workpiece, electrode extension from the contact tube, the speed of travel, and the gas shielding pattern.

When welding in the overhead position, welders must take special care to keep spatter, or molten metal from falling back on the gun nozzle and contact tube, as well as on themselves.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M17) dealing with understanding welding characteristics of various shielding gases.

WLD-M16-HO1
Control Weld Technique
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand weld requirements; and,
B. Understand weld techniques to produce specific welds.

MODULE OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of GMAW equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Increase skill level to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using GMAW short circuit transfer on various metals
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use approved welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-M16-HO2
Control Weld Technique
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30□ bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M17

SUBJECT: **WELDING TECHNICIAN** **TIME: 6 HOURS**

- **DUTY:** **GMAW SHORT CIRCUIT TRANSFER (INTERMEDIATE)**
- **TASK:** Understand Welding Characteristics of Various Shielding Gases

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand gas bottle safety; and,

B. Perform welds on various metals using various shielding gas and gas mixes.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M17-HO1)
MASTER Handout No. 2 (WLD-M17-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need for shielding gases
- A class demonstration of effective use of shielding gases

PRESENTATION OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of GMAW equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Demonstrate knowledge of adequate preparation of welding surfaces

F. Increase skill level to pass qualification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using GMAW short circuit transfer on various metals
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Select approved shielding gases
B. Preheat weld surface
C. Perform welds in four positions
D. Use approved and appropriate welding technique
E. Perform single pass and multi-pass welds
F. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience with practice in the use of shielding gases. The choice of the best shielding gas for a given GMAW application depends on many factors -- desired arc and metal transfer conditions, required penetration and fusion, shape of the finished weld, and welding speed.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

Shielding gases have specific applications leading to desired outcomes. The main purpose of a shielding gas is to protect the molten weld puddle from contamination by the atmosphere. The most common shielding gases used in GMAW are argon (chemical symbol AR), helium (He), and carbon dioxide (CO_2). Both argon and helium are true inert gases, but carbon dioxide is not. Each of these gases can be used alone as a "pure" shielding gas. However, they are usually combined in varying proportions to achieve desired conditions of the welding area.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M18) dealing with post-cleaning weld.

WLD-M17-HO1
Understand Welding Characteristics of Various Shielding Gases
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand gas bottle safety; and,

B. Perform welds on various metals using various shielding gas and gas mixes.

MODULE OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of GMAW equipment

B. Demonstrate knowledge of joint design and welding terms

C. Demonstrate ability to interpret drawings and blueprints

D. Demonstrate knowledge of the proper application of welding skills

E. Demonstrate knowledge of adequate preparation of welding surfaces

F. Increase skill level to pass qualification tests offered by an employer

G. Prepare butt joints, and tee joints, for welding

H. Increase knowledge of current industry standards and techniques

I. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions

J. Identify polarity requirements using GMAW short circuit transfer on various metals

K. Demonstrate preheat and how to maintain desired temperature

L. Identify welding variables and their effects on weld quality

M. Identify the AISI steel classification system

N. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Select approved shielding gases

B. Preheat weld surface

C. Perform welds in four positions

D. Use approved and appropriate welding technique

E. Perform single pass and multi-pass welds

F. Make adjustments to improve weld quality

WLD-M17-HO2
Understand Welding Characteristics of Various Shielding Gases
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

- a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
- b. Choose the correct electrode for given material and applications both type and size
- c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld 1/4" fillet welds in 2F position using string bead technique
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   - g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a Inspect the work area and equipment for safety
    - b Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f Weld root upwards
    - g Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i Complete the second pass using GMAW and upward Z weave technique
    - j Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k Make fourth and final pass with the same technique.
    - l The electrode is weaved from one bevel edge to another
    - m Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M18

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **GMAW SHORT CIRCUIT TRANSFER (INTERMEDIATE)**
- **TASK:** Post-Clean Weld

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand weld surface preparation;
B. Understand the use of solvents to clean weld surfaces; and,
C. Understand the process chipping and grinding.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M18-HO1)
MASTER Handout No. 2 (WLD-M18-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition

Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition

Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need for surface preparation
- A class demonstration of effective preparations and cleaning techniques

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Weld surface preparation
B. Cleaning of weld surfaces
C. Knowledge of the proper application of welding skills
D. Knowledge of current industry standards and techniques
E. Identify welding variables and their effects on weld quality

F. Identify the AISI steel classification system
G. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use approved welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality
F. Post-clean weld

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

There is very little requirement for cleaning with GMAW processes. With exception of flux cored electrodes used in the FCAW process, there is so flux and therefore no slag removal required. With proper welding processes and procedures, there should be little or no spatter from welding. Chipping, grinding, and finishing will be at a minimum.

Welders improve their techniques and methods with practice in GMAW short circuit transfer that corresponds with realistic industry standards and expectations.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M19) dealing with performing interpass preparation.

WLD-M18-HO1
Post-Clean Weld
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand weld surface preparation;
B. Understand the use of solvents to clean weld surfaces; and,
C. Understand the process chipping and grinding.

MODULE OUTLINE:

Instructor Topics:

A. Weld surface preparation
B. Cleaning of weld surfaces
C. Knowledge of the proper application of welding skills
D. Knowledge of current industry standards and techniques
E. Identify welding variables and their effects on weld quality
F. Identify the AISI steel classification system
G. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use approved welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality
F. Post-clean weld

WLD-M18-HO2
Post-Clean Weld
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M19

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **GMAW SHORT CIRCUIT TRANSFER (INTERMEDIATE)**
- **TASK:** Perform Interpass Preparation

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand welding requirements;
B. Understand the use of various tools to prepare welding surfaces; and,
C. Understand the purpose of interpass.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M19-HO1)
MASTER Handout No. 2 (WLD-M19-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need for interpass methods
- A class demonstration of effective interpass techniques
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Discuss pre-heating and maintaining interpass temperatures
B. Emphasizes the principles involved in preheating and reducing the quench rate
C. Demonstrate preheat and how to maintain desired temperature
D. Demonstrate knowledge of joint design and welding terms
E. Demonstrate knowledge of adequate preparation of welding surfaces

F. Prepare butt joints, and tee joints, for welding
G. Demonstrate knowledge of the proper application of welding skills
H. Identify the AISI steel classification system
I. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
J. Increase skill level to pass certification or qualification tests offered by an employer
K. Identify polarity requirements using GMAW short circuit transfer on various metals
L. Identify welding variables and their effects on weld quality
M. Increase knowledge of current industry standards and techniques
N. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds, maintaining recommended interpass temperatures
C. Use approved welding techniques
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience with practice in preheating, and maintaining interpass temperatures.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Welds will be inspected using AWS standards by the student and instructor, who will also review student's interpass procedures.

SUMMARY:

A metal that requires preheating to a specified temperature must also be kept at this temperature between weld passes. Heat input during welding may be sufficient, but on larger weldments torch heating between passes may be required.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M20) dealing with demonstrating short circuit GMAW flat horizontal, vertical and overhead.

WLD-M19-HO1
Perform Interpass Preparation
Attachment 1: MASTER **Handout** No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand welding requirements;
B. Understand the use of various tools to prepare welding surfaces; and,
C. Understand the purpose of interpass.

MODULE OUTLINE:

Instructor Topics:

A. Discuss pre-heating and maintaining interpass temperatures
B. Emphasizes the principles involved in preheating and reducing the quench rate
C. Demonstrate preheat and how to maintain desired temperature
D. Demonstrate knowledge of joint design and welding terms
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Prepare butt joints, and tee joints, for welding
G. Demonstrate knowledge of the proper application of welding skills
H. Identify the AISI steel classification system
I. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
J. Increase skill level to pass certification or qualification tests offered by an employer
K. Identify polarity requirements using GMAW short circuit transfer on various metals
L. Identify welding variables and their effects on weld quality
M. Increase knowledge of current industry standards and techniques
N. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds, maintaining recommended interpass temperatures
C. Use approved welding techniques
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-M19-HO2
Perform Interpass Preparation
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M20

SUBJECT: **WELDING TECHNICIAN** **TIME: 10 HOURS**

- **DUTY:** **GMAW SHORT CIRCUIT TRANSFER (INTERMEDIATE)**
- **TASK:** Demonstrate Short Circuit GMAW Flat Horizontal, Vertical and Overhead

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to perform welds in flat, horizontal, vertical and overhead positions using GMAW equipment.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on GMAW procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M20-HO1)
MASTER Handout No. 2 (WLD-M20-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of GMAW applications
- A class demonstration of effective welding in flat, horizontal, vertical, and overhead positions
- A discussion on methods leading to an increase of skill and knowledge

PRESENTATION OUTLINE:

Instructor Topics:

A. Discuss the need for specific techniques and adjustments that maximize weld quality in multiple positions
B. Emphasizes the principles involved in the weld sequence/control of basic variables and operation of GMAW equipment
C. Demonstrate knowledge of the proper application of welding skills
D. Demonstrate knowledge of adequate preparation of welding surfaces
E. Demonstrate ability to interpret drawings and blueprints

F. Demonstrate knowledge of joint design and welding terms
G. Prepare butt joints, and tee joints, for welding
H. Identify polarity requirements using GMAW short circuit transfer on various metals
I. Maximize GMAW quality using short circuit transfer in the flat, horizontal, vertical and overhead positions
J. Increase knowledge of current industry standards and techniques
K. Identify welding variables and their effects on weld quality
L. Identify the AISI steel classification system
M. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use approved welding techniques, with major consideration for safety
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience with applications in multiple positions, following proper weld sequence, control of basic variables improving technique and maximizing safety considerations.

EVALUATION AND/OR VERIFICATION:

Two examinations will be given during this module to determine the progress of the class. Quality of welds will be emphasized and each weldment will e inspected by the student and the instructor.

SUMMARY:

Welding techniques need to be appropriate for the approved procedure and application, with full consideration for the metals being welded, the position of welding, and the shielding gases.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M21) dealing with post finishing weld.

WLD-M20-HO1

Demonstrate Short Circuit GMAW Flat Horizontal, Vertical and Overhead

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to perform welds in flat, horizontal, vertical and overhead positions using GMAW equipment.

MODULE OUTLINE:

Instructor Topics:

A. Discuss the need for specific techniques and adjustments that maximize weld quality in multiple positions
B. Emphasizes the principles involved in the weld sequence/control of basic variables and operation of GMAW equipment
C. Demonstrate knowledge of the proper application of welding skills
D. Demonstrate knowledge of adequate preparation of welding surfaces
E. Demonstrate ability to interpret drawings and blueprints
F. Demonstrate knowledge of joint design and welding terms
G. Prepare butt joints, and tee joints, for welding
H. Identify polarity requirements using GMAW short circuit transfer on various metals
I. Maximize GMAW quality using short circuit transfer in the flat, horizontal, vertical and overhead positions
J. Increase knowledge of current industry standards and techniques
K. Identify welding variables and their effects on weld quality
L. Identify the AISI steel classification system
M. Match GMAW electrodes to an appropriate base metal

Student Activities:

A Preheat weld surface
B Perform welds in four positions
C Use approved welding techniques, with major consideration for safety
D Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-M20-HO2
Demonstrate Short Circuit GMAW Flat Horizontal, Vertical and Overhead
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

  a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
  b. Choose the correct electrode for given material and applications both type and size
  c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
  a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
  b. Choose the correct electrode for given material and applications both type and size
  c. Set voltage and wire feed speed for a given application, material and material thickness

8. Weld T Joints on Carbon Steel Using GMAW Equipment
  a. Inspect area for safety
  b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
  c. Adjust the welding parameters for this task
  d Tack a T joint using GMAW
  e Weld 1/4" fillet welds in 2F position using string bead technique
  f Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
  g Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"

9. Weld Multi-Pass Fillet Welds - All Positions
  a Inspect area for safety
  b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
  c Adjust the welding parameters for this task
  d Tack a T joint using GMAW
  e Weld the second pass with electrode centered at the bottom toe of the first pass
  f Weld the third pass with electrode centered at the top toe of the second pass
  g Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
  a Inspect area for safety
  b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
  c. Adjust the welding parameters for this task
  d Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M21

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **GMAW SHORT CIRCUIT TRANSFER (INTERMEDIATE)**
- **TASK:** Post Finish Weld

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand welding requirements; and,

B. Understand adjustments of GMAW equipment to increase weld quality.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M21-HO1)
MASTER Handout No. 2 (WLD-M21-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R., Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition

Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition

Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of procedures for weld post-finish
- A class demonstration of effective post-finish techniques
- A discussion on methods leading to an increase of skill and knowledge

PRESENTATION OUTLINE:

Instructor Topics:

A. Presents post-finish weld methods and techniques
B. Emphasizes the principles involved in the operating of GMAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Increase skill level to pass certification tests offered by an employer
H. Prepare butt joints, and tee joints, for welding

I. Increase knowledge of current industry standards and techniques
J. Maximize GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
K. Identify polarity requirements using GMAW short circuit transfer on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality
F. Post-finish weld

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

Welders improve their techniques and methods with practice that is benchmarked with AWS standards.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M22) dealing with describing GMAW filler wires.

WLD-M21-HO1
Post Finish Weld
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand welding requirements; and,
B. Understand adjustments of GMAW equipment to increase weld quality.

MODULE OUTLINE:

Instructor Topics:

A. Presents post-finish weld methods and techniques
B. Emphasizes the principles involved in the operating of GMAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Increase skill level to pass certification tests offered by an employer
H. Prepare butt joints, and tee joints, for welding
I. Increase knowledge of current industry standards and techniques
J. Maximize GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
K. Identify polarity requirements using GMAW short circuit transfer on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality
F. Post-finish weld

1741

WLD-M21-HO2
Post Finish Weld
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld 1/4" fillet welds in 2F position using string bead technique
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   - g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M22

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **GMAW SHORT CIRCUIT TRANSFER (INTERMEDIATE)**
- **TASK:** Describe GMAW Filler Wires

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand filler metal related to the job requirements.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M22-HO1)
MASTER Handout No. 2 (WLD-M22-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of this selection process for GMAW filler wires
- A class demonstration of selection of filler wires
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Discuss the process of filler wire selection; emphasizes the principles involved in the operating of GMAW equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Increase knowledge of current industry standards and techniques
F. Maximize GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions

G. Identify polarity requirements using GMAW short circuit transfer on various metals
H. Demonstrate preheat and how to maintain desired temperature
I. Identify welding variables and their effects on weld quality
J. Identify the AISI steel classification system
K. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Select, install, and adjust electrode filler wires
B. Preheat weld surface
C. Perform welds in four positions
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience with selection, installation, and adjustment of filler wires.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Student selection and wire feed adjustments will be observed by the instructor.

SUMMARY:

Welders improve their techniques and methods with practice that is benchmarked with AWS standards.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M23) dealing with describing basic weld discontinuities.

WLD-M22-HO1
Describe GMAW Filler Wires
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand filler metal related to the job requirements.

MODULE OUTLINE:

Instructor Topics:

A. Discuss the process of filler wire selection; emphasizes the principles involved in the operating of GMAW equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Increase knowledge of current industry standards and techniques
F. Maximize GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
G. Identify polarity requirements using GMAW short circuit transfer on various metals
H. Demonstrate preheat and how to maintain desired temperature
I. Identify welding variables and their effects on weld quality
J. Identify the AISI steel classification system
K. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Select, install, and adjust electrode filler wires
B. Preheat weld surface
C. Perform welds in four positions
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-M22-HO2
Describe GMAW Filler Wires
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   - a. Install adapter for particular brand of wire feeder
   - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   - c. Screw on gas defuser and tighten allen screw
   - d. Install contact tip
   - e. Install gas nozzle
   - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   - a. Compare and contrast constant current and constant voltage power sources
   - b. List effects of inductance on circuit
   - c. List effects of pinch effect
3. Shielding Gas Application
   - a. List arc characteristics caused by welding with 100% carbon dioxide
   - b. List arc characteristics caused by welding with 100% argon
   - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld 1/4" fillet welds in 2F position using string bead technique
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   - g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M23

WELDER SERIES

MASTER Technical Module No. WLD-M23

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **GMAW SHORT CIRCUIT TRANSFER (INTERMEDIATE)**
- **TASK:** Describe Basic Weld Discontinuities

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the welders responsibilities related to discontinuities and defects;
B. Identify and define discontinuities and defects;
C. Understand causes of discontinuities related to shape, size and contour;
D. Understand causes of discontinuities related to internal inconsistencies and weld metal irregularities; and,
E. Understand common causes of discontinuities related to weld and base metal properties.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M23-HO1)
MASTER Handout No. 2 (WLD-M23-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of causes of weld discontinuities
- A class demonstration of causes demonstrating improper and proper techniques
- A discussion on methods leading to an increase of skill and knowledge in order to be diversified, and a more valuable employee

PRESENTATION OUTLINE:

Instructor Topics:

A. Discuss the causes and prevention of weld discontinuities
B. Emphasizes the principles involved in the operating of GMAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Increase skill level to pass certification tests offered by an employer
H. Prepare butt joints, and tee joints, for welding
I. Increase knowledge of current industry standards and techniques
J. Maximize GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
K. Identify polarity requirements using GMAW short circuit transfer on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use approved welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

An examination will be given during this module to determine the progress of the class.

SUMMARY:

Welders improve their techniques and methods with the use of approved methods and techniques that will prevent discontinuities.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M24) dealing with demonstrating pre-weld cleaning.

WLD-M23-HO1
Describe Basic Weld Discontinuities
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the welders responsibilities related to discontinuities and defects;
B. Identify and define discontinuities and defects;
C. Understand causes of discontinuities related to shape, size and contour;
D. Understand causes of discontinuities related to internal inconsistencies and weld metal irregularities; and,
E. Understand common causes of discontinuities related to weld and base metal properties.

MODULE OUTLINE:

Instructor Topics:

A. Discuss the causes and prevention of weld discontinuities
B. Emphasizes the principles involved in the operating of GMAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Increase skill level to pass certification tests offered by an employer
H. Prepare butt joints, and tee joints, for welding
I. Increase knowledge of current industry standards and techniques
J. Maximize GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
K. Identify polarity requirements using GMAW short circuit transfer on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use approved welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-M23-HO2
Describe Basic Weld Discontinuities
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
b. Choose the correct electrode for given material and applications both type and size
c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		← Tasks												→
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purposes of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement technique	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and groove welds in T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDs.PM0
071996

1762

1763

Duty M3

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	← Tasks →												
M2 GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3 GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1 Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2 Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES

MASTER Technical Module No. WLD-M24

SUBJECT: WELDING TECHNICIAN **TIME: 3 HOURS**

- **DUTY:** GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)
- **TASK:** Demonstrate Pre-Weld Cleaning

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate the safe method of cleaning surfaces to be welded using hand tools (wire brush, power tools, etc); and,

B. Describe surface preparation procedures using cleaning solvents such as acetone.

INSTRUCTIONAL MATERIALS:

Student Workbook
One written test on GMAW pre-weld cleaning and preparation
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M24-HO1)
MASTER Handout No. 2 (WLD-M24-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need for pre-weld cleaning
- A class demonstration of effective pre-weld cleaning techniques
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Introduction to gas metal arc with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures

D. Pre-weld cleaning methods
E. Preparation and assembly of various materials and shapes
F. Describe AISI Classification System
G. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
H. Make adjustments on GMAW equipment and process to improve weld quality
I. Demonstrate visual, guided bend, and nick break test on various metals.

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform guided bend and nick break test

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Instructor will observe pre-weld cleaning and preparation methods.

SUMMARY:

Welders improve their techniques and methods with practice that is benchmarked with AWS standards.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M25) dealing with demonstrating interpass cleaning.

WLD-M24-HO1
Demonstrate Pre-Weld Cleaning
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate the safe method of cleaning surfaces to be welded using hand tools (wire brush, power tools, etc); and,

B. Describe surface preparation procedures using cleaning solvents such as acetone.

MODULE OUTLINE:

Instructional Topics:

A. Introduction to gas metal arc with spray and pulsed spray transfer welding plate and pipe

B. Discussion on the safety and health of welders

C. A discussion on set-up, operation, and shut down procedures

D. Pre-weld cleaning methods

E. Preparation and assembly of various materials and shapes

F. Describe AISI Classification System

G. Describe the most common weldability problems with aluminum, stainless steel and carbon steel

H. Make adjustments on GMAW equipment and process to improve weld quality

I. Demonstrate visual, guided bend, and nick break test on various metals.

Student Activities:

A. Set-up welding station

B. Tack weld joints

C. Clean weld surface

D. Deposit root pass

E. Deposit multiple pass to fill groove

F. Perform guided bend and nick break test

WLD-M24-HO2
Demonstrate Pre-Weld Cleaning
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass .
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M25

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)**
- **TASK:** Demonstrate Interpass Cleaning

OBJECTIVE(S):

Upon completion of this unit the student will be able to perform material and weld cleaning after each weld pass is applied using wire brush, or power tools with or without cleaning solvents such as acetone

INSTRUCTIONAL MATERIALS:

Student Workbook
One written test on GMAW procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M25-HO1)
MASTER Handout No. 2 (WLD-M25-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need for interpass cleaning
- A class demonstration of effective interpass cleaning techniques
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Introduction to gas metal arc with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders
C. Discussion on set-up, operation, and shut down procedures
D. Discussion of interpass cleaning techniques
E. Explain and demonstrate interpass cleaning with pipe
F. Preparation and assembly of various materials and shapes
G. Describe AISI Classification System

H. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
I. Make adjustments on GMAW equipment and process to improve weld quality
J. Demonstrate visual, guided bend, and nick break test on various metals.

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Deposit root pass
E. Perform interpass cleaning
F. Deposit multiple pass to fill groove

PRACTICAL APPLICATION:

The student will gain knowledge and experience with interpass cleaning techniques.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Student interpass cleaning methods will be monitored and critiqued by the instructor.

SUMMARY:

Welders improve their techniques and methods with practice that is benchmarked with AWS standards.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M26) dealing with demonstrating adjustment to pulse and spray transfer machines.

WLD-M25-HO

Demonstrate Interpass Cleaning

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to perform material and weld cleaning after each weld pass is applied using wire brush, or power tools with or without cleaning solvents such as acetone

---

MODULE OUTLINE:

Instructional Topics:

A. Introduction to gas metal arc with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders
C. Discussion on set-up, operation, and shut down procedures
D. Discussion of interpass cleaning techniques
E. Explain and demonstrate interpass cleaning with pipe
F. Preparation and assembly of various materials and shapes
G. Describe AISI Classification System
H. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
I. Make adjustments on GMAW equipment and process to improve weld quality
J. Demonstrate visual, guided bend, and nick break test on various metals.

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Deposit root pass
E. Perform interpass cleaning
F. Deposit multiple pass to fill groove

WLD-M25-HO2
Demonstrate Interpass Cleaning
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M26

WELDER SERIES

MASTER Technical Module No. WLD-M26

SUBJECT: WELDING TECHNICIAN TIME: 4 HOURS

- **DUTY: GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)**
- **TASK:** Demonstrate Adjustment to Pulse and Spray Transfer Machines

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform welds using spray and pulsed spray transfer with FCAW, and GMAW equipment;
B. Identify weld variables in the weld quality; and,
C. Make adjustments to GMAW and FCAW equipment to improve weld quality.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW welding procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M26-HO1)
MASTER Handout No. 2 (WLD-M26-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #S1077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition

Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition

Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of pulse and spray machine adjustments
- A class demonstration of effective machine adjustment techniques
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Discussion of pulse and spray machine adjustments
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various materials and shapes for GMAW
E. Describe AISI Classification System

F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate destructive and non-destructive tests on various metals welded for pipe

Student Activities:

A. Set-up welding station
B. Perform adjustments on pulse and spray machines
C. Clean weld surface
D. Tack weld joints
E. Deposit root pass
F. Perform interpass
G. Deposit multiple pass to fill groove on various metals
H. Perform destructive and non-destructive tests

PRACTICAL APPLICATION:

The student will gain knowledge and experience with pulse and spray machine adjustments. Destructive and non-destructive tests with pipe welds will be performed by the student and critiqued by the instructor.

EVALUATION AND/OR VERIFICATION:

Two examinations will be given at the end of this section to determine the progress of the class. Adjustments and tests will be evaluated by instructor.

SUMMARY:

Welders improve their techniques and methods with practice in pipe welding and testing that is benchmarked with AWS standards and approved procedures.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M27) dealing with demonstrating GMAW in flat, horizontal, vertical and overhead positions.

WLD-M26-HO1
Demonstrate Adjustment to Pulse and Spray Transfer Machines
Attachment 1:- MASTER Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform welds using spray and pulsed spray transfer with FCAW, and GMAW equipment;
B. Identify weld variables in the weld quality; and,
C. Make adjustments to GMAW and FCAW equipment to improve weld quality.

MODULE OUTLINE:

Instructional Topics:

A. Discussion of pulse and spray machine adjustments
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various materials and shapes for GMAW
E. Describe AISI Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate destructive and non-destructive tests on various metals welded for pipe

Student Activities:

A. Set-up welding station
B. Perform adjustments on pulse and spray machines
C. Clean weld surface
D. Tack weld joints
E. Deposit root pass
F. Perform interpass
G. Deposit multiple pass to fill groove on various metals
H. Perform destructive and non-destructive tests

WLD-M26-HO2
Demonstrate Adjustment to Pulse and Spray Transfer Machines
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M27

SUBJECT: **WELDING TECHNICIAN** **TIME: 12 HOURS**

- **DUTY:** **GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)**
- **TASK:** Demonstrate GMAW in Flat, Horizontal, Vertical and Overhead Positions

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Prepare material for welding;
B. Place material in a designated angle to perform weld;
C. Perform weld sequence in the flat position using GMAW spray and pulsed spray transfer;
D. Perform weld sequence in the horizontal position using GMAW spray and pulsed spray transfer;
E. Perform weld sequence in the vertical position using GMAW spray and pulsed spray transfer; and,
F. Perform weld sequence in the overhead position using GMAW spray and pulsed spray transfer.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on GMAW welding procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M27-HO1)
MASTER Handout No. 2 (WLD-M27-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of GMAW spray and pulsed spray in multiple positions
- A class demonstration of effective GMAW spray and pulsed spray techniques
- A discussion on methods leading to an increase of skill and knowledge

PRESENTATION OUTLINE:

Instructional Topics:

A. Introduction to gas metal arc with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various materials and shapes
E. Describe AISI Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate non-destructive and destructive test on various metals.

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Perform flat groove and fillet welds, and horizontal fillet welds
E. Deposit root pass
F. Deposit multiple pass to fill groove
G. Perform vertical and overhead welds under the direct supervision of the instructor
H. Perform nondestructive and destructive testing

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

Two examinations will be given during this module to determine the progress of the class. Welds will be evaluated by the student and the instructor.

SUMMARY:

Welders improve their techniques and methods with continued practice that is benchmarked with AWS standards. Spray transfer is accomplished by the movement of a stream of tiny droplets of molten weld metal from the electrode, across the welding arc column, to the base metal. It is performed with relatively high load voltages and high amperages with arc argon or argon shielding gas . Amperage is determined by electrode type and diameter (size). Pulsed (current) spray is slower than true spray transfer and produce less heat input to the base metal. It can be used to join their sections of metal, and is suitable for all welding positions.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M28) dealing with pre-heating joint, if required; understanding joint preparation.

WLD-M27-HO1

Demonstrate GMAW in Flat, Horizontal, Vertical and Overhead Positions

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Prepare material for welding;
B. Place material in a designated angle to perform weld;
C. Perform weld sequence in the flat position using GMAW spray and pulsed spray transfer;
D. Perform weld sequence in the horizontal position using GMAW spray and pulsed spray transfer;
E. Perform weld sequence in the vertical position using GMAW spray and pulsed spray transfer; and,
F. Perform weld sequence in the overhead position using GMAW spray and pulsed spray transfer.

MODULE OUTLINE:

Instructional Topics:

A. Introduction to gas metal arc with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various materials and shapes
E. Describe AISI Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate non-destructive and destructive test on various metals.

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Perform flat groove and fillet welds, and horizontal fillet welds
E. Deposit root pass
F. Deposit multiple pass to fill groove
G. Perform vertical and overhead welds under the direct supervision of the instructor
H. Perform nondestructive and destructive testing

WLD-M27-HO2
Demonstrate GMAW in Flat, Horizontal, Vertical and Overhead Positions
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a Inspect area for safety
    b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c Adjust the welding parameters for this task
    d Tack a T joint using GMAW
    e Weld the second pass with electrode centered at the bottom toe of the first pass
    f Weld the third pass with electrode centered at the top toe of the second pass
    g Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a Inspect area for safety
    b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c Adjust the welding parameters for this task
    d Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M28

SUBJECT: WELDING TECHNICIAN **TIME: 3 HOURS**

- **DUTY:** **GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)**
- **TASK:** Pre-Heat Joint, If Required; Understand Joint Preparation

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand welding requirements for penetration and preparation of surfaces; and,

B. Perform pre-heat on 3/8 and 3/4 plus 1 inch steel and aluminum plate.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW welding procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M28-HO1)
MASTER Handout No. 2 (WLD-M28-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition

Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition

Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of GMAW spray and pulsed spray procedures
- A class demonstration of effective GMAW spray and pulsed spray techniques
- A discussion on methods leading to an increase of skill and knowledge

PRESENTATION OUTLINE:

Instructional Topics:

A. Introduction to gas metal arc with spray and pulsed spray transfer, welding plate and pipe

B. Discussion on the safety and health of welders

C. A discussion on set-up, operation, and shut down procedures

D. Preparation and assembly of various materials and shapes
E. Describe AISI Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate non-destructive and destructive testing on various metals.

Student Activities:

A. Set-up welding station
B. Pre-heat joint
C. Tack weld joints
D. Use of spray and pulsed spray arc process
E. Clean weld surface
F. Deposit root pass
G. Deposit multiple pass to fill groove and fillet on various metals
H. Perform Non-destructive and destructive tests as assigned by instructor

---

PRACTICAL APPLICATION:

The student will practice with spray transfer and pulsed spray GMAW.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

In the spray transfer method, the arc heats the end of the electrode and fine droplets melt and form a stream across the arc gap. The spray transfer produces a buzzing sound, producing higher heat input, greater penetration and a higher deposition rate than other forms of transfer.

The pulsed current arc process is a spray transfer process wherein one small drop of molten metal is transferred across the arc for each high current pulse of weld current. During the low current portion of the weld cycle, the arc is maintained and the wire is heated, but the heat developed is not adequate to transfer any metal. Gases for pulsed arc welding are argon plus 1 % oxygen, the same as used for spray arc welding. Thin material can be welded, producing a smooth weld with less current.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M29) dealing with initiating welding process.

WLD-M28-HO1

Pre-Heat Joint, If Required; Understand Joint Preparation

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand welding requirements for penetration and preparation of surfaces; and,

B. Perform pre-heat on 3/8 and 3/4 plus 1 inch steel and aluminum plate.

MODULE OUTLINE:

Instructional Topics:

A. Introduction to gas metal arc with spray and pulsed spray transfer, welding plate and pipe

B. Discussion on the safety and health of welders

C. A discussion on set-up, operation, and shut down procedures

D. Preparation and assembly of various materials and shapes

E. Describe AISI Classification System

F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel

G. Make adjustments on GMAW equipment and process to improve weld quality

H. Demonstrate non-destructive and destructive testing on various metals.

Student Activities:

A. Set-up welding station

B. Pre-heat joint

C. Tack weld joints

D. Use of spray and pulsed spray arc process

E. Clean weld surface

F. Deposit root pass

G. Deposit multiple pass to fill groove and fillet on various metals

H. Perform Non-destructive and destructive tests as assigned by instructor

WLD-M28-HO2
Pre-Heat Joint, If Required; Understand Joint Preparation
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M29

SUBJECT: WELDING TECHNICIAN TIME: 5 HOURS

- **DUTY: GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)**
- **TASK:** Initiate Welding Process

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand weld requirements from procedure;
B. Check all parameters of adjustment; and,
C. Initiate specific process from a procedure.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW welding procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M29-HO1)
MASTER Handout No. 2 (WLD-M29-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of special considerations for GMAW for pipes and AISI Code requirements
- A class demonstration of pipe welding techniques
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Introduction to AISI Code requirements for GMAW for pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures

D. Preparation and assembly of various materials and shapes
E. Describe AISI Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate visual, guided bend, and nick break test on various metals.
I. Perform inspection weld tests on various metals

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Perform root pass
E. Deposit multiple pass to fill groove
F. Perform guided bend and nick break test

PRACTICAL APPLICATION:

The student will gain knowledge and experience practice with the pulsed arc process (spray transfer) and pulsed GMAW spray techniques.

EVALUATION AND/OR VERIFICATION:

An examination will be given during this module to determine the progress of the class. Welds will be inspected by student and instructor.

SUMMARY:

Pulsed GMAW is a modification of arc and spray transfer welding. Pulsed GMAW characteristics show excellent transfer with lower currents. Advantages include low spatter and penetration without melt-through.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M30) dealing with performing weld sequence.

WLD-M29-HO1
Initiate Welding Process
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand weld requirements from procedure;
B. Check all parameters of adjustment; and,
C. Initiate specific process from a procedure.

MODULE OUTLINE:

Instructional Topics:

A. Introduction to AISI Code requirements for GMAW for pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various materials and shapes
E. Describe AISI Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate visual, guided bend, and nick break test on various metals.
I. Perform inspection weld tests on various metals

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Perform root pass
E. Deposit multiple pass to fill groove
F. Perform guided bend and nick break test

WLD-M29-HO2
Initiate Welding Process
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness.
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Tack a T joint using GMAW
    - e. Weld 1/4" fillet welds in 2F position using string bead technique
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    - g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Tack a T joint using GMAW
    - e. Weld the second pass with electrode centered at the bottom toe of the first pass
    - f. Weld the third pass with electrode centered at the top toe of the second pass
    - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a Inspect the work area and equipment for safety
    b Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c Use grind to clean the bevel face and apply a 3/32" root face
    d Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f Weld root upwards
    g Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i Complete the second pass using GMAW and upward Z weave technique
    j Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k Make fourth and final pass with the same technique.
    l The electrode is weaved from one bevel edge to another
    m Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M30

WELDER SERIES

MASTER Technical Module No. WLD-M30

SUBJECT: **WELDING TECHNICIAN** **TIME: 10 HOURS**

- **DUTY:** **GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)**
- **TASK:** Perform Weld Sequence

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand sequence of welding application;
B. Test parameters of adjustment; and,
C. Make adjustments to equipment to ensure quality of welds.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on GMAW welding procedures
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M30-HO1)
MASTER Handout No. 2 (WLD-M30-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of possible and recommended adjustments with GMAW spray and pulsed spray
- A class demonstration of effective welding techniques
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Practical applications using gas metal arc with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders

C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various materials and shapes
E. Describe AISI Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate visual, and recommended tests on various metals.

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform recommended tests on various metals

PRACTICAL APPLICATION:

The student will gain knowledge and experience with practical exercises in GMAW spray and pulsed spray.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Work will be inspected and tested by student and instructor.

SUMMARY:

Diameters of electrode wires for GMAW are generally between 0.030 and 3/32 inches. For each electrode diameter, there is a minimum welding current and voltage must be exceeded to achieve spray transfer.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M31) dealing with describing AISI stainless steels classification system.

WLD-M30-HO1

Perform Weld Sequence

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand sequence of welding application;
B. Test parameters of adjustment; and,
C. Make adjustments to equipment to ensure quality of welds.

MODULE OUTLINE:

Instructional Topics:

A. Practical applications using gas metal arc with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various materials and shapes
E. Describe AISI Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate visual, and recommended tests on various metals.

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform recommended tests on various metals

WLD-M30-HO2
Perform Weld Sequence
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    - e. Weld the second pass with electrode centered at the bottom toe of the first pass
    - f. Weld the third pass with electrode centered at the top toe of the second pass
    - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M31

WELDER SERIES
MASTER Technical Module No. WLD-M31

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)**
- **TASK:** Describe AISI Stainless Steels Classification System

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand AISI code requirements.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on AISI stainless steels classification system
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M31-HO1)
MASTER Handout No. 2 (WLD-M31-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of GMAW spray and pulsed spray
- A class demonstration of effective GMAW spray and pulsed spray techniques
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Use of GMAW with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures with spray techniques
D. Preparation and assembly of various alloy pipe work pieces
E. Describe AISI Stainless Steel Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality

H. Perform inspections and weld tests on various metals

Student Activities:

A. Set-up welding station
B. Tack pipe of various alloys in 5G and 6G positions
C. Clean weld joint surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform guided bend and nick break test

PRACTICAL APPLICATION:

This module focuses on how to obtain a level of confidence in this procedure, before starting on a work piece. If any questions arise, the students will check with their supervisor to make changes and determine optimum welding techniques.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

Proper understanding of the AISI stainless steels classification system is necessary to selection and welding of stainless steels.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M32) dealing with describing weldability problems associated with straight chromium, nickel and stainless steel.

WLD-M31-HO1
Describe AISI Stainless Steels Classification System
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand AISI code requirements.

MODULE OUTLINE:

Instructional Topics:

A. Use of GMAW with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures with spray techniques
D. Preparation and assembly of various alloy pipe work pieces
E. Describe AISI Stainless Steel Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Perform inspections and weld tests on various metals

Student Activities:

A. Set-up welding station
B. Tack pipe of various alloys in 5G and 6G positions
C. Clean weld joint surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform guided bend and nick break test

WLD-M31-HO2
Describe AISI Stainless Steels Classification System
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

  - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
  - b. Choose the correct electrode for given material and applications both type and size
  - c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld 1/4" fillet welds in 2F position using string bead technique
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   - g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

e. Weld the second pass with electrode centered at the bottom toe of the first pass
f. Weld the third pass with electrode centered at the top toe of the second pass
g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M32

WELDER SERIES
MASTER Technical Module No. WLD-M32

SUBJECT: **WELDING TECHNICIAN** **TIME: 6 HOURS**

- **DUTY:** **GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)**
- **TASK:** Describe Weldability Problems Associated With Straight Chromium, Nickel, and Stainless Steel

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand chromium and stainless steel alloy compatibility; and,
B. Understand weldability problems with nickel.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on Gas Metal Arc Welding pipe
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M32-HO1)
MASTER Handout No. 2 (WLD-M32-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of typical welding problems in production welding
- A class demonstration of effective techniques with chromium, nickel, and stainless steel
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Production welding for Gas Metal Arc Welding Pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures

D. Preparation and assembly of various alloy pipe work pieces
E. Describe AISI Stainless Steel Classification System
F. Describe the most common weldability problems with chromium, nickel, and stainless steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate visual, guided bend, and nick break test on various metals.

Student Activities:

A. Set-up welding station
B. Tack pipe of various alloys in 5G and 6G positions
C. Clean weld joint surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform guided bend and nick break test

PRACTICAL APPLICATION

This module will increase student level of confidence in using GMAW spray and pulsed spray procedures for pipe welding. Visual inspection after welding and heat treatment, if any, shall determine that the weld is free from cracks, surface porosity, and unfilled craters, and that the weld face is at least flush with the outside surface of the pipe. The root of the weld shall show no evidence of cracks or incomplete fusion.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Welds will be inspected and tested by student and instructor.

SUMMARY:

Some stainless steels have a tendency toward hot cracking or tearing. When welding these, more welding passes than indicated in procedures may be needed. Stringer bead techniques are also recommended rather than weaving or oscillating. Preheating helps to improve bead contour and weld-metal hot cracking may also be reduced by short-circuiting transfer welding.

Alloys can be used for hard surfacing. A major disadvantage of GMAW for hard surfacing is that not all surfacing alloys are available in the necessary form (rolls or spools of wire). Nickel-chromium-boron alloys form deposits consisting of hard carbides and borides in a nickel base. The alloys provide good metal-to-metal wear resistance compared to an alloy steel of the same hardness.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M33) dealing with describing detrimental effects of vibration on the life of piping systems.

WLD-M32-HO1

Describe Weldability Problems Associated with Straight Chromium, Nickel and Stainless Steel

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand chromium and stainless steel alloy compatibility; and,
B. Understand weldability problems with nickel.

MODULE OUTLINE:

Instructional Topics:

A. Production welding for Gas Metal Arc Welding Pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various alloy pipe work pieces
E. Describe AISI Stainless Steel Classification System
F. Describe the most common weldability problems with chromium, nickel, and stainless steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate visual, guided bend, and nick break test on various metals.

Student Activities:

A. Set-up welding station
B. Tack pipe of various alloys in 5G and 6G positions
C. Clean weld joint surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform guided bend and nick break test

WLD-M32-HO2
Describe Weldability Problems Associated with Straight Chromium, Nickel and Stainless Steel
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

6. Weld With GMAW Using Globular Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer.
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a Inspect area for safety
    b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c Adjust the welding parameters for this task
    d Tack a T joint using GMAW
    e Weld the second pass with electrode centered at the bottom toe of the first pass
    f Weld the third pass with electrode centered at the top toe of the second pass
    g Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10 Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a Inspect area for safety
    b Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M33

WELDER SERIES
MASTER Technical Module No. WLD-M33

SUBJECT: WELDING TECHNICIAN TIME: 4 HOURS

- **DUTY: GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)**
- **TASK:** Describe Detrimental Effects of Vibration on the Life of Piping Systems

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the effects of pressure and steam on metal piping systems; and,
B. Understand the effects of vibration.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on Gas Metal Arc Welding pipe
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M33-HO1)
MASTER Handout No. 2 (WLD-M3-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the effects of pressure, steam, and vibration on piping systems
- A class demonstration of stress on piping systems
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Effects of pressure, steam, and vibration on piping systems
B. Gas Metal Arc Welding Pipe
C. Set-up, operation, and shut down procedures for GMAW -Pipe
D. Preparation and assembly of various alloy pipe work pieces

E. Describe AISI Stainless Steel Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. The reliability of pipe welds under stress
H. Make adjustments on GMAW equipment and process to improve weld quality
I. Demonstrate recommended tests
J. Welding techniques to counteract stress and strain on pipe welds

Student Activities:

A. Set-up welding station
B. Tack pipe of various alloys in 5G and 6G positions
C. Clean weld joint surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform recommended inspections and tests on welded pipe materials

---

PRACTICAL APPLICATION:

Students will note that discontinuities and incomplete welds can lead to premature failure.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Welds will be inspected by the student and the instructor and sufficient to destructive tests.

SUMMARY:

Welders improve their techniques and methods with a knowledge of the causes of premature failure..

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M34) dealing with describing methods of minimizing detrimental effects of pressure and heat on life of pipe systems.

WLD-M33-HO1
Describe Detrimental Effects of Vibration on Life of Piping Systems
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the effects of pressure and steam on metal piping systems; and,
B. Understand the effects of vibration.

MODULE OUTLINE:

Instructional Topics:

A. Effects of pressure, steam, and vibration on piping systems
B. Gas Metal Arc Welding Pipe
C. Set-up, operation, and shut down procedures for GMAW -Pipe
D. Preparation and assembly of various alloy pipe work pieces
E. Describe AISI Stainless Steel Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. The reliability of pipe welds under stress
H. Make adjustments on GMAW equipment and process to improve weld quality
I. Demonstrate recommended tests
J. Welding techniques to counteract stress and strain on pipe welds

Student Activities:

A. Set-up welding station
B. Tack pipe of various alloys in 5G and 6G positions
C. Clean weld joint surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform recommended inspections and tests on welded pipe materials

WLD-M33-HO2
Describe Detrimental Effects of Vibration on Life of Piping Systems
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c List effects of pinch effect
3. Shielding Gas Application
    a List arc characteristics caused by welding with 100% carbon dioxide
    b List arc characteristics caused by welding with 100% argon
    c List arc characteristics caused by welding with 75% Argon and 25% CO2
    d List arc characteristics caused by welding with 95% Argon and 5% CO2
    e List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b Choose the correct electrode for given material and applications both type and size
    c Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M34

SUBJECT: **WELDING TECHNICIAN** **TIME: 6 HOURS**

- **DUTY:** **GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)**
- **TASK:** Describe Methods of Minimizing Detrimental Effects of Pressure and Heat on Life of Piping Systems

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand material requirements and specifications.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on Gas Metal Arc Welding pipe
Transparencies will be prepared to emphasize each subject
Miller Module Method Video Materials
Hobart Institute Video Material
Student worksheets and alloy charts
GMAW equipment and accessories
Various types and sizes of electrode wires (labeled)
Personal protective equipment
Examples of welding guns (standard and 1 pound spools)
Examples of wire feeders
Shielding gas regulator-flow meters
Welding shop tools
MASTER Handout No. 1 (WLD-M34-HO1)
MASTER Handout No. 2 (WLD-M34-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the need to minimize detrimental effects of pressure and heat on piping systems
- A class demonstration of detrimental effects
- A discussion on methods leading to an increase of skill and knowledge

PRESENTATION OUTLINE:

Instructional Topics:

A. Analysis of detrimental effects on piping systems welds
B. Use of Gas Metal Arc Welding-Pipe
C. Discussion on the safety and health of welders
D. A discussion on set-up, control of variables, operation, and shut down procedures
E. Preparation and assembly of various alloy pipe work pieces
F. Describe AISI Stainless Steel Classification System

G. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
H. Make adjustments on GMAW equipment and process to improve weld quality
I. Demonstrate recommended and approved tests on pipe materials

Student Activities:

A. Set-up welding station
B. Tack pipe of various alloys in 5G and 6G positions
C. Clean weld joint surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform recommended and approved tests on pipe weldments

PRACTICAL APPLICATION:

Students will research ways of improving pipe welds by a greater knowledge of cause and effects.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Pipe systems welds will be examined and pressure tested.

SUMMARY:

A knowledge of cause and effects of failure sill assist the welder in performance of high quality of pipe welds. Welders improve their techniques and methods with continued practice that is benchmarked with AWS standards.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-M35) dealing with passing a performance qualification test using GMAW on pipe in the 6G position.

WLD-M34-HO1
Describe Methods of Minimizing Detrimental Effects Of Pressure and Heat on Life of Pipe Systems
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand material requirements and specifications.

MODULE OUTLINE:

Instructional Topics:

A. Analysis of detrimental effects on piping systems welds
B. Use of Gas Metal Arc Welding-Pipe
C. Discussion on the safety and health of welders
D. A discussion on set-up, control of variables, operation, and shut down procedures
E. Preparation and assembly of various alloy pipe work pieces
F. Describe AISI Stainless Steel Classification System
G. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
H. Make adjustments on GMAW equipment and process to improve weld quality
I. Demonstrate recommended and approved tests on pipe materials

Student Activities:

A. Set-up welding station
B. Tack pipe of various alloys in 5G and 6G positions
C. Clean weld joint surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform recommended and approved tests on pipe weldments

WLD-M34-HO2
Describe Methods of Minimizing Detrimental Effects Of Pressure and Heat on Life of Pipe Systems
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness

6. Weld With GMAW Using Globular Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a Inspect the work area and equipment for safety
    - b Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c Use grind to clean the bevel face and apply a 3/32" root face
    - d Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f Weld root upwards
    - g Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i Complete the second pass using GMAW and upward Z weave technique
    - j Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k Make fourth and final pass with the same technique.
    - l The electrode is weaved from one bevel edge to another
    - m Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER SERIES

MASTER Technical Module No. WLD-M35

SUBJECT: WELDING TECHNICIAN TIME: 6 HOURS

- **DUTY:** **GMAW SPRAY AND PULSED SPRAY, PIPE TRANSFER (ADVANCED)**
- **TASK:** Pass a Performance Qualification Test Using GMAW on Pipe in the 6G Position

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the procedures and applications for GMAW pulsed spray with pipe;
B. Learn standards and codes for piping; and,
C. With practice, pass a performance qualification test.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GMAW spray and pulsed spray pipe transfer
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
MASTER Handout No. 1 (WLD-M35-HO1)
MASTER Handout No. 2 (WLD-M35-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Specification for Qualification of Welding Procedures and Welders for Piping and Tubing, AWS D10.9, American Welding Society, Miami, FL, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Various publications referencing standards for pipe materials, the American Society for Testing Materials (ASTM), the American Society of Mechanical Engineers (ASME), the American Petroleum Institute (API), and the American Welding Society (AWS)
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Copper and Copper-Alloy Welding Rods, AWS A5.7-84, American Welding Society, Miami, FL, Latest Edition
Mechanical Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Impact - Property Requirements for Gas Metal Arc Welding Weld Metal, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition
Chemical - Composition Requirements for Gas Arc Welding Electrode, AWS A5.18-79, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of metal pipe materials and applications
- A class demonstration of effective GMAW pulsed spray transfer welding techniques
- Background on the need for standards and procedures for ratification

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Metal pipe materials and weld characteristics
  1. Cast iron,
  2. Low carbon or medium carbon steel
  3. Higher alloy steel
    a. Stainless steel

        - b. Aluminum
- B. Standards and codes for piping
    - 1. American Society for Testing Materials (ASTM)
    - 2. The American Society of Mechanical engineers (ASME)
    - 3. American Petroleum Institute (API)
    - 4. American Welding Society (AWS)
- C. Spray transfer methods for GMAW
- D. Use of shielding gas

Student Activities:

- A. Choose the correct shielding gas and flow rate for the given application, material, and material thickness
- B. Choose the correct electrode for given material and applications
- C. Set voltage and wire-feed speed for a given application, material, and material thickness
- D. Apply welding technique

PRACTICAL APPLICATION:

This module will assist the student in obtaining a level of confidence in the use of GMAW pulsed spray. With practice, the student can reach performance qualification levels.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Individual students will prepare for specified performance qualification test.

SUMMARY:

The GMAW spray Transfer Method makes good welds in thin-gage metals in all positions. It is also appropriate for vertical and overhead weld of heavy materials. The ability to bridge gaps with the spray transfer method makes it useful for welding joints with poor fit-up.

Welders improve their techniques and methods with continued practice that is benchmarked with AWS standards.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-N1) dealing with understanding the safety factors using FCAW equipment.

WLD-M35-HO1
Pass a Performance Qualification Test Using GMAW on Pipe in the 6G Position
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the procedures and applications for GMAW pulsed spray with pipe;
B. Learn standards and codes for piping; and,
C. With practice, pass a performance qualification test.

MODULE OUTLINE:

Instructional Topics:

A. Metal pipe materials and weld characteristics
  1. Cast iron,
  2. Low carbon or medium carbon steel
  3. Higher alloy steel
    a. Stainless steel
    b. Aluminum
B. Standards and codes for piping
  1. American Society for Testing Materials (ASTM)
  2. The American Society of Mechanical engineers (ASME)
  3. American Petroleum Institute (API)
  4. American Welding Society (AWS)
C. Spray transfer methods for GMAW
D. Use of shielding gas

Student Activities:

A. Choose the correct shielding gas and flow rate for the given application, material, and material thickness
B. Choose the correct electrode for given material and applications
C. Set voltage and wire-feed speed for a given application, material, and material thickness
D. Apply welding technique

WLD-M35-HO2
Pass a Performance Qualification Test Using GMAW on Pipe in the 6G Position
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

6. Weld With GMAW Using Globular Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with coworkers and supervisors						
E	Work as a Team	E-1 Understand the roles of coworkers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	[illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

1364

1365

Duty N

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Feel finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-N1

WELDER SERIES

MASTER Technical Module No. WLD-N01

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **FLUX CORE ARC WELDING (FCAW)**
- **TASK:** Understand the Safety Factors Using FCAW Equipment

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform safety inspection of work area;
B. Identify an unsafe work environment;
C. Understand the use of protective equipment and clothing; and,
D. Utilize FCAW equipment in a safe manner.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on FCAW safety and procedures
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
FCAW welding equipment
Power supply
Wire Feeder with guides and rollers
Shielding gas regulator and hose
Welding gun with contact tip
FCAW tubular electrode wire and shielding gas
Welding shop tools
MASTER Handout (WLD-N1-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Specification for Mild Steel Electrodes for Flux-Cored Arc Welding, AWS 5.20-69, American Welding Society, Miami, FL, Latest Edition

Specification for Flux-Cored Corrosion Resisting Chromium and Chromium-Nickel Steel Electrodes, AWS 5.22, American Welding Society, Miami, FL, Latest Edition

Specification for Low Alloy Steel Electrodes for Flux-Core Arc Welding, AWS 5.29, American Welding Society, Miami, FL, Latest Edition

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of FCAW applications and potential safety hazards
- A class demonstration of effective FCAW welding techniques
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Emphasize potential safety hazards with FCAW equipment
B. Emphasizes the principles involved in the operating of FCAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Increase skill level to pass certification tests offered by an employer
H. Prepare butt joints, and tee joints, for welding
I. Increase knowledge of current industry standards and techniques
J. Demonstrate FCAW in the flat, horizontal, vertical and overhead positions
K. Identify polarity requirements using FCAW on various metals

L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match FCAW electrodes to an appropriate base metal

Student Activities:

A. Identify all FCAW components and analyze them for potential safety hazards
B. Preheat weld surface
C. How to perform welds in four positions recommend and approved
D. How to use larger diameter flux cored electrodes for flat or horizontal filler welds only and use smaller diameter electrodes for all positions
E. Perform single pass and multi-pass welds
F. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The safety factors in FCAW welding operations are emphasized, along with safe welding procedures in all welding positions. The student must insure that the hose and cable assembly from the wire feeder to the torch is not put under severe bending stress. A worst case is this problem would cause a burnback of the electrode into the contact tube.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

This module introduces the student to Flux Core Arc Welding (FCAW) equipment and filler metals. Theory and safe operating procedures are emphasized. The FCAW process can make deep penetrating welds in mild steels, low alloy steels, and some stainless steels. For most FCAW applications, the power source ratings range from 450 to 650 amperes with maximum open circuit voltage at approximately 65 volts. The power sources have ratings at 100% duty cycle, and normally have remote voltage control capability.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-N2) dealing with troubleshooting FCAW equipment.

WLD-N1-HO
Understand the Safety Factors Using FCAW Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform safety inspection of work area;
B. Identify an unsafe work environment;
C. Understand the use of protective equipment and clothing; and,
D. Utilize FCAW equipment in a safe manner.

MODULE OUTLINE:

Instructor Topics:

A. Emphasize potential safety hazards with FCAW equipment
B. Emphasizes the principles involved in the operating of FCAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Increase skill level to pass certification tests offered by an employer
H. Prepare butt joints, and tee joints, for welding
I. Increase knowledge of current industry standards and techniques
J. Demonstrate FCAW in the flat, horizontal, vertical and overhead positions
K. Identify polarity requirements using FCAW on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match FCAW electrodes to an appropriate base metal

Student Activities:

A. Identify all FCAW components and analyze them for potential safety hazards
B. Preheat weld surface
C. How to perform welds in four positions recommend and approved
D. How to use larger diameter flux cored electrodes for flat or horizontal filler welds only and use smaller diameter electrodes for all positions
E. Perform single pass and multi-pass welds
F. Make adjustments to improve weld quality

WELDER SERIES

MASTER Technical Module No. WLD-N02

SUBJECT: WELDING TECHNICIAN **TIME: 4 HOURS**

- **DUTY:** **FLUX CORE ARC WELDING (FCAW)**
- **TASK:** Troubleshoot FCAW Equipment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform inspection of shielded and self-shielded FCAW equipment;
B. Perform equipment adjustments and repair;
C. Understand principles of FCAW process; and,
D. Understand terms and definitions.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on FCAW safety and procedures
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
FCAW welding equipment
Power supply
Wire Feeder with guides and rollers
Shielding gas regulator and hose
Welding gun with contact tip
FCAW tubular electrode wire and shielding gas
Welding shop tools
MASTER Handout (WLD-N2-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Specification for Mild Steel Electrodes for Flux-Cored Arc Welding, AWS 5.20-69, American Welding Society, Miami, FL, Latest Edition

Specification for Flux-Cored Corrosion Resisting Chromium and Chromium-Nickel Steel Electrodes, AWS 5.22, American Welding Society, Miami, FL, Latest Edition
Specification for Low Alloy Steel Electrodes for Flux-Core Arc Welding, AWS 5.29, American Welding Society, Miami, FL, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of FCAW troubleshooting
- A class demonstration of equipment adjustments for optimum welds
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Discuss the principles involved in the operating of FCAW equipment
B. Present differences in SMAW, GMAW, and FCAW
C. Demonstrate set up of equipment and machine adjustments
D. Demonstrate applications of joint design and welding terms
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Prepare butt joints, and tee joints, for welding
G. Match FCAW electrodes to an appropriate base metal
H. Discuss electrode extension
I. Identify polarity requirements using FCAW on various metals
J. Identify the AISI steel classification system
K. Demonstrate FCAW in the flat, horizontal, vertical and overhead positions

Student Activities:

- A. Perform machine set up and troubleshooting
- B. Practice using FCAW tubular electrode wire
- C. Practice with proper electrode extension
- D. Preheat weld surface
- E. Perform welds in four positions
- F. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

Electrode extension, measured from the end of the copper contact tube, depends upon a variety of things including electrode type, diameter, and position of welding. With the solid metal sheathing, higher current and deposition rates are possible than with SMAW. The student should read electrode manufacturers instructions and follow them for best results. Student will practice changing the wire speed and adjusting the welding amperage or current and assess the advantages or disadvantages for the specific application.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Instructor will observe machine setup, electrode extension, and adjustments by the student.

SUMMARY:

FCAW is an arc welding process similar to GMAW that uses a continuously fed electrode. While GMAW uses a "solid" electrode wire, FCAW employs a tubular electrode wire, with a solid sheathing surrounding the "granular flux core" of the electrode, thus giving FCAW its name. The core of the electrode helps shield the welding arc. Depending on the application, flux cored electrodes may be self-shielded or gas shielded with an externally supplied gas. Better mechanical and physical weld properties can normally be expected from the gas shielded flux cored electrodes.

The core flux materials perform the same functions as the covering materials on a SMAW electrode. They form slag, deoxidize and clean the weld, supply alloys to the weld, stabilize the arc, and provide some shielding of the arc when a separate shielding gas is not supplied.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-N3) dealing with performing weld sequence.

WLD-N2-HO
Troubleshoot FCAW Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform inspection of shielded and self-shielded FCAW equipment;
B. Perform equipment adjustments and repair;
C. Understand principles of FCAW process; and,
D. Understand terms and definitions.

MODULE OUTLINE:

Instructor Topics:

A. Discuss the principles involved in the operating of FCAW equipment
B. Present differences in SMAW, GMAW, and FCAW
C. Demonstrate set up of equipment and machine adjustments
D. Demonstrate applications of joint design and welding terms
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Prepare butt joints, and tee joints, for welding
G. Match FCAW electrodes to an appropriate base metal
H. Discuss electrode extension
I. Identify polarity requirements using FCAW on various metals
J. Identify the AISI steel classification system
K. Demonstrate FCAW in the flat, horizontal, vertical and overhead positions

Student Activities:

A. Perform machine set up and troubleshooting
B. Practice using FCAW tubular electrode wire
C. Practice with proper electrode extension
D. Preheat weld surface
E. Perform welds in four positions
F. Make adjustments to improve weld quality

WLD-N3

WELDER SERIES
MASTER Technical Module No. WLD-N03

SUBJECT: **WELDING TECHNICIAN** **TIME: 8 HOURS**

- **DUTY:** **FLUX CORE ARC WELDING (FCAW)**
- **TASK:** Perform Weld Sequence

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Review safety requirements;
B. Perform Flux Core Arc Welding on steel and stainless steel in the flat, horizontal, vertical, and overhead position; and,
C. Practice FCAW using local industry standards as guidelines.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on FCAW safety and procedures
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
FCAW welding equipment
Power supply
Wire Feeder with guides and rollers
Shielding gas regulator and hose
Welding gun with contact tip
FCAW tubular electrode wire and shielding gas
Welding shop tools
MASTER Handout (WLD-N3-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Specification for Mild Steel Electrodes for Flux-Cored Arc Welding, AWS 5.20-69, American Welding Society, Miami, FL, Latest Edition

Specification for Flux-Cored Corrosion Resisting Chromium and Chromium-Nickel Steel Electrodes, AWS 5.22, American Welding Society, Miami, FL, Latest Edition

Specification for Low Alloy Steel Electrodes for Flux-Core Arc Welding, AWS 5.29, American Welding Society, Miami, FL, Latest Edition

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of sequence of operations with FCAW
- A class demonstration of effective FCAW welding techniques
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of FCAW equipment
B. Discuss the use of the FCAW flux cored tubular electrode
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills the FCAW
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Use larger electrodes in flat and horizontal positions only
J. Demonstrate FCAW in the flat, horizontal, vertical and overhead positions (using smaller diameter electrodes for vertical and overhead)

K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify polarity requirements using FCAW
N. Identify the AISI steel classification system
O. Match FCAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Use proper electrode extension
C. Perform welds in four positions
D. Use recommended and approved welding technique
E. Perform single pass and multi-pass welds
F. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

Students will learn proper weld sequences in this FCAW module. Welding with the FCAW process requires knowledge of torch handling techniques similar to those used with the GMAW process. In manual operations the FCAW gun is held almost perpendicular (at right angles) to the work.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Students will be observed using proper weld techniques. Welds will be inspected by the student and the instructor.

SUMMARY:

This module emphasizes production welding with FCAW in multiple positions. As with GMAW, the typical FCAW welding machine would be a DC constant potential type. The machine should be able to handle the highest amperage needed for the largest size electrode to be used. Most large sized flux cored electrode wires can require up to 650 amps for welding. Advantages of FCAW over SMAW are that the electrodes can deposit weld metal faster, and that long joints can be welded without stopping to replace consumed electrodes.

FCAW can make deep penetrating welds in mild steels, low alloy steels, and some stainless steels.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-N4) dealing with shutting down FCAW equipment.

WLD-N3-HO
Perform Weld Sequence
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Review safety requirements;
B. Perform Flux Core Arc Welding on steel and stainless steel in the flat, horizontal, vertical, and overhead position; and,
C. Practice FCAW using local industry standards as guidelines.

MODULE OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of FCAW equipment
B. Discuss the use of the FCAW flux cored tubular electrode
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills the FCAW
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Use larger electrodes in flat and horizontal positions only
J. Demonstrate FCAW in the flat, horizontal, vertical and overhead positions (using smaller diameter electrodes for vertical and overhead)
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify polarity requirements using FCAW
N. Identify the AISI steel classification system
O. Match FCAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Use proper electrode extension
C. Perform welds in four positions
D. Use recommended and approved welding technique
E. Perform single pass and multi-pass welds
F. Make adjustments to improve weld quality

WELDER SERIES

MASTER Technical Module No. WLD-N04

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **FLUX CORE ARC WELDING (FCAW)**
- **TASK:** Shut Down FCAW Equipment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Understand shut-down procedures with FCAW equipment; and
B. Perform shut-down procedures with FCAW equipment.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on FCAW safety and procedures
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
FCAW welding equipment
Power supply
Wire Feeder with guides and rollers
Shielding gas regulator and hose
Welding gun with contact tip
FCAW tubular electrode wire and shielding gas
Welding shop tools
MASTER Handout (WLD-N4-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Specification for Mild Steel Electrodes for Flux-Cored Arc Welding, AWS 5.20-69, American Welding Society, Miami, FL, Latest Edition

Specification for Flux-Cored Corrosion Resisting Chromium and Chromium-Nickel Steel Electrodes, AWS 5.22, American Welding Society, Miami, FL, Latest Edition
Specification for Low Alloy Steel Electrodes for Flux-Core Arc Welding, AWS 5.29, American Welding Society, Miami, FL, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the importance of proper FCAW shutdown
- A class demonstration of effective shutdown and securing equipment
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of FCAW equipment
B. Sequence of procedures for equipment shutdown
C. Securing of equipment
D. Safe maintenance and repair of equipment

Student Activities:

A. Shut down equipment, following approved sequence
B. Inspect for safety and make necessary repairs
C. Safely secure and store equipment

PRACTICAL APPLICATION:

Following shutdown, safe maintenance and repairs will be performed.

The student gains knowledge and experience with practice provided in this module.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Shutdown procedures will be observed by the instructor.

SUMMARY:

This module emphasizes proper shut down and maintenance of FCAW equipment. In wire feeder-control applications the wear and tear of system components must be considered. Following shutdown, welders should examine the inlet guide tube for grooves from electrode movement. The drive rolls can also wear until they are not usable. If work, they should be replaced before weld defects occur in later operations. Preventive maintenance is best performed during equipment down-time.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-O1) dealing with identifying GTAW equipment.

WLD-N4-HO
Shut Down FCAW Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand shut-down procedures with FCAW equipment; and
B. Perform shut-down procedures with FCAW equipment.

MODULE OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of FCAW equipment
B. Sequence of procedures for equipment shutdown
C. Securing of equipment
D. Safe maintenance and repair of equipment

Student Activities:

A. Shut down equipment, following approved sequence
B. Inspect for safety and make necessary repairs
C. Safely secure and store equipment

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDx.PM6
[illegible]

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
M2 GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3 GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1 Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2 Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U Wellness/Physical Abilities	U-1 Demonstrate ability to lift 80 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-01

WELDER SERIES

MASTER Technical Module No. WLD-O01

SUBJECT: **WELDING TECHNICIAN** **TIME: 6 HOURS**

- **DUTY:** **GAS TUNGSTEN ARC WELDING (GTAW) (BASIC)**
- **TASK:** Identify GTAW Equipment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand GTAW equipment identification; and,
B. Understand shielding gas equipment.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on Gas Tungsten Arc Welding
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
GTAW equipment
Power supply
Control unit with shielding gas equipment and GTAW air cooled or water cooled torch
Examples of tungsten electrodes
Examples of torch gas nozzles in various sizes and styles
Shielding gas regulator, flow meters and accessory equipment
Selected metals for welding exercises
Welding shop tools
MASTER Handout No. 1 (WLD-O1-HO1)
MASTER Handout No. 2 (WLD-O1-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of GTAW equipment
- A class demonstration of GTAW equipment
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Identify GTAW equipment
D. Troubleshoot and make minor repairs
E. Identify the AWS GTAW filler metal classification systems
F. Match filler electrodes to base metals
G. Identify GTAW welding variables and their effects on weld quality

Student Activities:

A. Set up GTAW equipment, identifying all components
B. Start up equipment, emphasizing safe procedures
C. Make adjustments to GTAW equipment and understand process steps to be followed

D. GTAW fillet and groove welds on T and butt-joints on various metals in various positions
E. Perform in process weld inspection

PRACTICAL APPLICATION:

This module emphasizes proper identification of GTAW equipment, familiarization with purpose and use and knowledge of shielding gases..

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Students will describe the functions, safety hazards, and operation of each piece of equipment

---

SUMMARY:

In this module, students learn to identify, assembly, and adjust GTAW equipment. The GTAW process produces welding heat with an arc in an inert shielding gas. Filler metal, as needed, is added by melting a rod into the weld puddle. The electrodes used are non-consumable tungsten materials. The welding process is often called the "TIG" process, for the words "tungsten inert gas." The AWS has selected the name "Gas Tungsten Arc Welding" as the correct professional name for the welding process.

The inert gases used are argon (Ar), or helium (He), or their combinations.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-O2) dealing with identifying the safety standards.

WLD-O1-HO1
Identify GTAW Equipment
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Understand GTAW equipment identification; and,
B. Understand shielding gas equipment.

MODULE OUTLINE:

Instructional Topics:
A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Identify GTAW equipment
D. Troubleshoot and make minor repairs
E. Identify the AWS GTAW filler metal classification systems
F. Match filler electrodes to base metals
G. Identify GTAW welding variables and their effects on weld quality

Student Activities:
A. Set up GTAW equipment, identifying all components
B. Start up equipment, emphasizing safe procedures
C. Make adjustments to GTAW equipment and understand process steps to be followed
D. GTAW fillet and groove welds on T and butt-joints on various metals in various positions
E. Perform in process weld inspection

WLD-O1-HO2
Identify GTAW Equipment
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
   - a. List advantages and disadvantages of GTAW
   - b. List five applications where GTAW or PAW are better suited
   - c. List give applications which are more suited to SMAW than GTAW
   - d. Compare and contrast GTAW and plasma arc welding (PAC)
   - e. List by name the parts of a GTAW torch
   - f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
   - g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 2F position
   - f. Weld a .050" fillet weld using .045" ER308-L
   - g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 3F vertical position
   - f. Weld a .050" fillet weld using .045" ER308-L
   - g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 4F overhead position

    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

- a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
- b. Cut stainless steel and grind a .30" bevel on edges
- c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
- d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
- e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
   - a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
   - b. Prepare tungsten for given procedure
   - c. Set up GTAW torch for given procedure
   - d. Set current for procedure
   - e. Adjust shielding gas flow rate
   - f. Weld root using free hand technique and using the walking the cup method
   - g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    - a. Use non-low hydrogen electrodes
    - b. Strike arc and hold long arc length 1" away from last weld crater
    - c. Back-up to previous weld crater holding long arc length
    - d. Pre-heat crater with long arc
    - e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    - a. Use low hydrogen electrodes
    - b. Strike arc 1" from crater
    - c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    - d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    - a. List the names and draw side views of the five basic joint configurations
    - b. List the names and draw side views of the variations of grooves
    - c. List the names and draw side views of the T-Joint variations
    - d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    - a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    - b. Clean bevel face with grinder as required
    - c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
c. List the polarity that air carbon arc is run on
d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
e. Connect air carbon torch arc and compressed air hose to welding machine
f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    a. Locate root of weld
    b. Demonstrate control of depth of cut
    c. Demonstrate control of width of cut
    d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    e. Make gouges of uniform depth
    f. Observe discontinuities as gouging proceeds
    g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    a Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    b Measure to make sure excavation is at proper location and depth
    c Use air carbon arc equipment. Shape excavation to ensure proper fusion
    d Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    a Check area for safety
    b Set SMAW equipment current and polarity for 1/8" E7018
    c Attach work lead
    d Preheat and maintain interpass temperature as required
    e Weld first pass paying special attention to low hydrogen techniques
    f Grind the weld start and stop to remove cold lap and lack of fusion
    g Weld the second pass starting from opposite end
    h Repeat starts and stops until weld is completed
    i Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    a Check work area for safety
    b Position steel in a T joint and tack at ends
    c Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

Name: ______________________________ Date: ____________________

WLD-O1
Identify GTAW Equipment
Self-Assessment

Circle the best answer.

1. Tungsten is a metal with which of the following physical properties?
    - A. High strength and good electrical conductivity
    - B. Highest melting point of any element
    - C. High yield and high ductility
    - D. Low yield, high strength, and good insulation

2. The end of the filler rod must be kept close to the weld zone
    - A. Because it is much easier to see and control
    - B. To prevent it from becoming oxidized
    - C. To keep the rod hot so it melts more easily
    - D. To keep the rod cool to it does not melt

3. The best working temperature for a tungsten is when it is
    - A. Above a white hot temperature
    - B. Below a dull red temperature
    - C. Above a dull red temperature
    - D. Just above room temperature

4. Excessively high shielding gas flow rates can
    - A. Help protect the weld
    - B. Reduce oxide contamination
    - C. Prevent arc blow
    - D. Cause turbulence and poor weld puddle shielding

5. The grinding stone used to shape a tungsten should be
    - A. A fine, hard stone
    - B. Coarse, in order to quickly shape the tungsten
    - C. Used only for tungsten and stainless steels
    - D. Both B and C

6. Why is post-welding gas flow required?
    - A. To protect the hot tungsten from oxidation
    - B. To protect the hot weld metal from oxidation
    - C. To prevent oxides from entering the weld pool
    - D. Both A and B

7. Which tip color is used to identify pure tungsten?
   - A. Green
   - B. Yellow
   - C. Red
   - D. Blue

8. Post-weld gas flow time should be
   - A. At least 20 seconds
   - B. For as long as the weld is hot
   - C. Set according to the cup and tungsten sizes used
   - D. No longer than needed to protect the tungsten and weld

9. Argon is used as a shield gas with GTAW because argon
   - A. Is lighter than air
   - B. Allows cathodic cleaning
   - C. Produces deep penetration
   - D. Prevents electrode waste

10. If the water supply is suddenly shut off, a water cooled GTA welding torch power cable will
    - A. Work like an air-cooled torch cable
    - B. Automatically stop the current
    - C. Rapidly overheat
    - D. Have no problem carrying the welding current

WELDER SERIES

MASTER Technical Module No. WLD-O02

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **GAS TUNGSTEN ARC WELDING (GTAW) (BASIC)**
- **TASK:** Identify the Safety Standards

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand GTAW principles of operation; and,
B. Understand storage and safe handling of inert shielding gas.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on Gas Tungsten Arc Welding safety
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
GTAW equipment
Power supply
Control unit with shielding gas equipment and GTAW air cooled or water cooled torch
Examples of tungsten electrodes
Examples of torch gas nozzles in various sizes and styles
Shielding gas regulator, flow meters and accessory equipment
Selected metals for welding exercises
Welding shop tools
MASTER Handout No. 1 (WLD-O2-HO1)
MASTER Handout No. 2 (WLD-O2-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- The importance of safety standards for GTAW operations
- A discussion on methods leading to a continued awareness of potential safety hazards

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the types of shielding gas and gas mixtures
C. Identify GTAW equipment and possible safety hazards
D. Electrode holder assembly
E. Compressed gas cylinders and flow meters
F. Storage and handling of shielding gases (argon, helium)
G. Welding power sources and safe range of operations
H. Safe trouble-shooting and repair methods

Student Activities:

A. Inspect all equipment with safety as a major consideration
B. Set up and test GTAW equipment for safe operation
C. Perform a hazards analysis of the workplace

PRACTICAL APPLICATION:

The purpose of this module is to assist the student in the identification of safety standards and necessary precautions in GTAW operations.

This module will provide practice in insuring safe operations with GTAW.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Students will demonstrate safe handling of equipment and perform a hazards analysis of the workplace.

SUMMARY:

Safety with GTAW involves the proper use of shielding gases, the water cooled welding torch, the heat of the process, and the power source, among many other aspects. The type of welding current needed will depend on the type of metal to be welded and the desired arc characteristics. DCEN provides a stable arc and makes a narrow bead with deep penetration. DCEP produces wide welds with shallow penetration, and has a strong cleaning action.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-O3) dealing with describing the preventive and protective measures

WLD-O2-HO1
Identify the Safety Standards
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Understand GTAW principles of operation; and,
B. Understand storage and safe handling of inert shielding gas.

PRESENTATION OUTLINE:

Instructional Topics:
A. Summary of safety precautions
B. Identify the types of shielding gas and gas mixtures
C. Identify GTAW equipment and possible safety hazards
D. Electrode holder assembly
E. Compressed gas cylinders and flow meters
F. Storage and handling of shielding gases (argon, helium)
G. Welding power sources and safe range of operations
H. Safe trouble-shooting and repair methods

Student Activities:
A. Inspect all equipment with safety as a major consideration
B. Set up and test GTAW equipment for safe operation
C. Perform a hazards analysis of the workplace

WLD-O2-HO2

Identify the Safety Standards

Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
   - a. List advantages and disadvantages of GTAW
   - b. List five applications where GTAW or PAW are better suited
   - c. List give applications which are more suited to SMAW than GTAW
   - d. Compare and contrast GTAW and plasma arc welding (PAC)
   - e. List by name the parts of a GTAW torch
   - f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
   - g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 2F position
   - f. Weld a .050" fillet weld using .045" ER308-L
   - g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 3F vertical position
   - f. Weld a .050" fillet weld using .045" ER308-L
   - g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 4F overhead position

    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
    a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
    b. Prepare tungsten for given procedure
    c. Set up GTAW torch for given procedure
    d. Set current for procedure
    e. Adjust shielding gas flow rate
    f. Weld root using free hand technique and using the walking the cup method
    g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    a. Use non-low hydrogen electrodes
    b. Strike arc and hold long arc length 1" away from last weld crater
    c. Back-up to previous weld crater holding long arc length
    d. Pre-heat crater with long arc
    e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    a. Use low hydrogen electrodes
    b. Strike arc 1" from crater
    c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    a. List the names and draw side views of the five basic joint configurations
    b. List the names and draw side views of the variations of grooves
    c. List the names and draw side views of the T-Joint variations
    d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    b. Clean bevel face with grinder as required
    c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

    a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
    b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
    c. List the polarity that air carbon arc is run on
    d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
    e. Connect air carbon torch arc and compressed air hose to welding machine
    f. Inspect area for safety
15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    a. Locate root of weld
    b. Demonstrate control of depth of cut
    c. Demonstrate control of width of cut
    d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    e. Make gouges of uniform depth
    f. Observe discontinuities as gouging proceeds
    g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    b. Measure to make sure excavation is at proper location and depth
    c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    a. Check area for safety
    b. Set SMAW equipment current and polarity for 1/8" E7018
    c. Attach work lead
    d. Preheat and maintain interpass temperature as required
    e. Weld first pass paying special attention to low hydrogen techniques
    f. Grind the weld start and stop to remove cold lap and lack of fusion
    g. Weld the second pass starting from opposite end
    h. Repeat starts and stops until weld is completed
    i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    a. Check work area for safety
    b. Position steel in a T joint and tack at ends
    c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

Name: ______________________________ Date: ____________________

WLD-O2
Identify the Safety Standards
Self-Assessment

Circle the best answer.

1. Tungsten is a metal with which of the following physical properties?
    - A. High strength and good electrical conductivity
    - B. Highest melting point of any element
    - C. High yield and high ductility
    - D. Low yield, high strength, and good insulation

2. The end of the filler rod must be kept close to the weld zone
    - A. Because it is much easier to see and control
    - B. To prevent it from becoming oxidized
    - C. To keep the rod hot so it melts more easily
    - D. To keep the rod cool to it does not melt

3. The best working temperature for a tungsten is when it is
    - A. Above a white hot temperature
    - B. Below a dull red temperature
    - C. Above a dull red temperature
    - D. Just above room temperature

4. Excessively high shielding gas flow rates can
    - A. Help protect the weld
    - B. Reduce oxide contamination
    - C. Prevent arc blow
    - D. Cause turbulence and poor weld puddle shielding

5. The grinding stone used to shape a tungsten should be
    - A. A fine, hard stone
    - B. Coarse, in order to quickly shape the tungsten
    - C. Used only for tungsten and stainless steels
    - D. Both B and C

6. Why is post-welding gas flow required?
    - A. To protect the hot tungsten from oxidation
    - B. To protect the hot weld metal from oxidation
    - C. To prevent oxides from entering the weld pool
    - D. Both A and B

7. Which tip color is used to identify pure tungsten?
   A. Green
   B. Yellow
   C. Red
   D. Blue

8. Post-weld gas flow time should be
   A. At least 20 seconds
   B. For as long as the weld is hot
   C. Set according to the cup and tungsten sizes used
   D. No longer than needed to protect the tungsten and weld

9. Argon is used as a shield gas with GTAW because argon
   A. Is lighter than air
   B. Allows cathodic cleaning
   C. Produces deep penetration
   D. Prevents electrode waste

10. If the water supply is suddenly shut off, a water cooled GTA welding torch power cable will
   A. Work like an air-cooled torch cable
   B. Automatically stop the current
   C. Rapidly overheat
   D. Have no problem carrying the welding current

WLD-03

WELDER SERIES

MASTER Technical Module No. WLD-O03

SUBJECT: WELDING TECHNICIAN TIME: 4 HOURS

- **DUTY: GAS TUNGSTEN ARC WELDING (GTAW) (BASICI)**
- **TASK:** Describe the Preventive and Protective Measures

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify to gas tungsten arc welding components;
B. Use shielding gas equipment and accessories component identification;
C. Demonstrate the functions gas tungsten arc welding components;
D. Provide demonstrations in the use of protective clothing and preventive action arc welding equipment and accessories;
E. Perform minor external repairs on shielding gas equipment and accessories; and,
F. Understand and prevent injury from electric shock, fires, explosions, lack of ventilation, and exposure to infrared and ultraviolet radiation.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on GTAW preventive and protective measures
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
GTAW equipment
Power supply
Control unit with shielding gas equipment and GTAW air cooled or water cooled torch
Examples of tungsten electrodes
Examples of torch gas nozzles in various sizes and styles
Various types of filler metal rods
Shielding gas regulator, flow meters and accessory equipment
Selected metals for welding exercises
Welding shop tools
MASTER Handout No. 1 (WLD-O3-HO1)
MASTER Handout No. 2 (WLD-O3-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- The importance of preventive and protective measures that must be known and followed by the welder.

PRESENTATION OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance of using shielding gas mixtures in a safe manner
C. Identify GTAW equipment, and areas of greatest potential hazards
D. Discuss safe and unsafe methods of operation
E. Troubleshoot and make minor repairs
F. Matching of electrodes to base metals
G. Identify the AWS GTAW filler metal classification systems
H. Identify GTAW welding variables and their effects on weld quality

Student Activities:

- A. Wear protective equipment
- B. Follow preventive and protective measures
- C. Set up GTAW equipment
- D. Make adjustments to GTAW equipment and process to improve weld quality
- E. Make repairs assigned by instructor

PRACTICAL APPLICATION:

This module will provide necessary orientation on use of protective equipment and the need for preventive measures.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. The instructor will observe student implementing safety repair practices and using proper terms and definitions.

SUMMARY:

The purpose of this module is to assist the student in the use of preventive and protective measures.

GTAW has developed into a most reliable method of making extremely high quality welds. As in other welding operations, the operator assumes major responsibilities for safety and must plan ahead with preventive measures to preclude accidents and hazardous occurrences.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-O4) dealing with identifying the welding variables and their effects upon weld quality

WLD-O3-HO1
Describe the Preventive and Protective Measures
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify to gas tungsten arc welding components;
B. Use shielding gas equipment and accessories component identification;
C. Demonstrate the functions gas tungsten arc welding components;
D. Provide demonstrations in the use of protective clothing and preventive action arc welding equipment and accessories;
E. Perform minor external repairs on shielding gas equipment and accessories; and,
F. Understand and prevent injury from electric shock, fires, explosions, lack of ventilation, and exposure to infrared and ultraviolet radiation.

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance of using shielding gas mixtures in a safe manner
C. Identify GTAW equipment, and areas of greatest potential hazards
D. Discuss safe and unsafe methods of operation
E. Troubleshoot and make minor repairs
F. Matching of electrodes to base metals
G. Identify the AWS GTAW filler metal classification systems
H. Identify GTAW welding variables and their effects on weld quality

Student Activities:

A. Wear protective equipment
B. Follow preventive and protective measures
C. Set up GTAW equipment
D. Make adjustments to GTAW equipment and process to improve weld quality
E. Make repairs assigned by instructor

WLD-O3-HO2
Describe the Preventive and Protective Measures
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
   - a. List advantages and disadvantages of GTAW
   - b. List five applications where GTAW or PAW are better suited
   - c. List give applications which are more suited to SMAW than GTAW
   - d. Compare and contrast GTAW and plasma arc welding (PAC)
   - e. List by name the parts of a GTAW torch
   - f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
   - g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 2F position
   - f. Weld a .050" fillet weld using .045" ER308-L
   - g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 3F vertical position
   - f. Weld a .050" fillet weld using .045" ER308-L
   - g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 4F overhead position

    - f. Weld a .050" fillet weld using .045" ER308-L
    - g. Visually inspect joint for burn through, weld size and workmanship
5. Weld on 1/8" Material and 100% Penetration
    - a. Conduct safety inspection of the area and equipment
    - b. Weld on 304 stainless steel
    - c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    - d. Cut stainless steel and grind a .30" bevel on edges
    - e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    - f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    - g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    - a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    - b. Cut stainless steel and grind a .30" bevel on edges
    - c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    - d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    - e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    - a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    - b. Cut stainless steel and grind a .30" bevel on edges
    - c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    - d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    - e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

  a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
  b. Cut stainless steel and grind a .30" bevel on edges
  c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
  d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
  e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
  a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
  b. Prepare tungsten for given procedure
  c. Set up GTAW torch for given procedure
  d. Set current for procedure
  e. Adjust shielding gas flow rate
  f. Weld root using free hand technique and using the walking the cup method
  g. Apply second pass using weave

10. Produce Welds with Properly Fused Starts and Filled Craters
  a. Use non-low hydrogen electrodes
  b. Strike arc and hold long arc length 1" away from last weld crater
  c. Back-up to previous weld crater holding long arc length
  d. Pre-heat crater with long arc
  e. Shorten arc length, fill crater and continue welding

11. Low Hydrogen Starts and Stops
  a. Use low hydrogen electrodes
  b. Strike arc 1" from crater
  c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
  d. Pause at the crater when it is filled. Continue welding

12. Design Welded Joints
  a. List the names and draw side views of the five basic joint configurations
  b. List the names and draw side views of the variations of grooves
  c. List the names and draw side views of the T-Joint variations
  d. List the name of the type of weld made in each joint

13. Weld V Groove With Backing in Flat Position
  a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
  b. Clean bevel face with grinder as required
  c. Cut 1/4" material for backing strip

14. Set Up Air Carbon Arc Equipment for Gouging

- a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
- b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
- c. List the polarity that air carbon arc is run on
- d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
- e. Connect air carbon torch arc and compressed air hose to welding machine
- f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    - a. Locate root of weld
    - b. Demonstrate control of depth of cut
    - c. Demonstrate control of width of cut
    - d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    - e. Make gouges of uniform depth
    - f. Observe discontinuities as gouging proceeds
    - g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    - a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    - b. Measure to make sure excavation is at proper location and depth
    - c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    - d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    - a. Check area for safety
    - b. Set SMAW equipment current and polarity for 1/8" E7018
    - c. Attach work lead
    - d. Preheat and maintain interpass temperature as required
    - e. Weld first pass paying special attention to low hydrogen techniques
    - f. Grind the weld start and stop to remove cold lap and lack of fusion
    - g. Weld the second pass starting from opposite end
    - h. Repeat starts and stops until weld is completed
    - i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    - a. Check work area for safety
    - b. Position steel in a T joint and tack at ends
    - c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    - d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    - e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

Name: ______________________________ Date: ____________________

WLD-O3
Describe the Preventive and Protective Measures
Self-Assessment

Circle the best answer.

1. Tungsten is a metal with which of the following physical properties?
   A. High strength and good electrical conductivity
   B. Highest melting point of any element
   C. High yield and high ductility
   D. Low yield, high strength, and good insulation

2. The end of the filler rod must be kept close to the weld zone
   A. Because it is much easier to see and control
   B. To prevent it from becoming oxidized
   C. To keep the rod hot so it melts more easily
   D. To keep the rod cool to it does not melt

3. The best working temperature for a tungsten is when it is
   A. Above a white hot temperature
   B. Below a dull red temperature
   C. Above a dull red temperature
   D. Just above room temperature

4. Excessively high shielding gas flow rates can
   A. Help protect the weld
   B. Reduce oxide contamination
   C. Prevent arc blow
   D. Cause turbulence and poor weld puddle shielding

5. The grinding stone used to shape a tungsten should be
   A. A fine, hard stone
   B. Coarse, in order to quickly shape the tungsten
   C. Used only for tungsten and stainless steels
   D. Both B and C

6. Why is post-welding gas flow required?
   A. To protect the hot tungsten from oxidation
   B. To protect the hot weld metal from oxidation
   C. To prevent oxides from entering the weld pool
   D. Both A and B

7. Which tip color is used to identify pure tungsten?
   A. Green
   B. Yellow
   C. Red
   D. Blue

8. Post-weld gas flow time should be
   A. At least 20 seconds
   B. For as long as the weld is hot
   C. Set according to the cup and tungsten sizes used
   D. No longer than needed to protect the tungsten and weld

9. Argon is used as a shield gas with GTAW because argon
   A. Is lighter than air
   B. Allows cathodic cleaning
   C. Produces deep penetration
   D. Prevents electrode waste

10. If the water supply is suddenly shut off, a water cooled GTA welding torch power cable will
    A. Work like an air-cooled torch cable
    B. Automatically stop the current
    C. Rapidly overheat
    D. Have no problem carrying the welding current

WLD-04

WELDER SERIES

MASTER Technical Module No. WLD-O04

SUBJECT: **WELDING TECHNICIAN** **TIME: 6 HOURS**

- **DUTY:** **GAS TUNGSTEN ARC WELDING (GTAW) (BASIC)**
- **TASK:** Identify the Welding Variables and Their Effects Upon Weld Quality

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide instruction in gas tungsten arc welding principles of operation;
B. Understand shielding gases as related to the gas tungsten arc welding process;
C. Understand the performance and functions of aluminum and stainless steel shapes, and identification/selection;
D. Perform tungsten electrode identification/selection for plain carbon steel, aluminum and stainless steel;
E. Perform gas tungsten arc welding filler metal identification/selection for plain carbon steel, aluminum, and stainless steel; and,
F. Understand gas tungsten arc welding principles of operation, aluminum and stainless steel weldability, and filler metal classification portion of a summative closed book examination.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on Gas Tungsten Arc Welding
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
GTAW equipment
Power supply
Control unit with shielding gas equipment and GTAW air cooled or water cooled torch
Examples of tungsten electrodes
Examples of torch gas nozzles in various sizes and styles
Various types of filler metal rods
Shielding gas regulator, flow meters and accessory equipment
Selected metals for welding exercises
Welding shop tools

MASTER Handout No. 1 (WLD-O4-HO1)
MASTER Handout No. 2 (WLD-O4-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Gas Tungsten Arc Welding, AWS Welding Handbook, Volume 1, Latest Edition
Welding Technology, Chapter 4, Welding Metallurgy, ANSI/AWS A5/18, American Welding Society, Miami, FL, Latest Edition
Specification for Carbon Steel Filler Metals for Gas Shielded Arc Welding, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.9, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Stainless Steel Electrodes and Rods, ANSI/AWS A5.12, American Welding Society, Miami, FL, Latest Edition
Specification for Tungsten and Tungsten Alloy Electrodes for Arc Welding and Cutting, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of weld variables for GTAW
- A class demonstration of effective GTAW techniques
- A discussion on methods leading to producing high quality weldments

PRESENTATION OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Identify GTAW equipment
D. Troubleshoot and make minor repairs
E. Match electrodes to base metals
F. Identify the AWS GTAW filler metal classification systems
G. The GTAW process
H. Identify GTAW welding variables and their effects on weld quality

Student Activities:

A. Identify weld variables and plan their input settings and control for quality outcomes
B. Input of variables (setting and controls) for specific welds
C. Make adjustments to GTAW equipment and process to improve weld quality
D. Set up GTAW equipment
E. Perform in process weld inspection
F. Perform in process rework (if required)
G. Discuss weld

PRACTICAL APPLICATION:

The purpose of this program is to assist the student in understanding the weld variables and their effects on weld quality.

This module will provide understanding and practice for the student in GTAW.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Welds will be examined and inspected for quality.

SUMMARY:

The basic equipment used in the GTAW process is different than the SMAW process. Power source configurations differ with the type of metals, and usually have special equipment such as gas valves and solenoids. Torches may be air cooled or water cooled. The water cooled torch channels shielding gas to the arc area and holds the tungsten electrode while passing current through the torch body and collect to the electrode. Among the many GTAW equipment and process variables are: voltage, amps, current (AC or DC), polarity, torch configuration, compatibility and characteristics of metals and alloys to be welded, cooling method, use of shielding gas or self shielding electrodes, special electrodes, weld techniques, specified weldment limitations, electrode extension, weld positions, types of joints, and specific treatments as required used on specification. These many variables cause the welder to study the design of the weld process, plan and control the variables relative to the specific job, and apply weld techniques, procedures, and adjustments to obtain the optimum weld, based upon the specifications.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-O5) dealing with troubleshooting equipment.

WLD-O4-HO1

Identify the Welding Variables and Their Effects Upon Weld Quality

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide instruction in gas tungsten arc welding principles of operation;

B. Understand shielding gases as related to the gas tungsten arc welding process;

C. Understand the performance and functions of aluminum and stainless steel shapes, and identification/selection;

D. Perform tungsten electrode identification/selection for plain carbon steel, aluminum and stainless steel;

E. Perform gas tungsten arc welding filler metal identification/selection for plain carbon steel, aluminum, and stainless steel; and,

F. Understand gas tungsten arc welding principles of operation, aluminum and stainless steel weldability, and filler metal classification portion of a summative closed book examination.

PRESENTATION OUTLINE:

Instructional Topics:

A. Summary of safety precautions

B. Identify the importance and variations of shielding gas mixtures

C. Identify GTAW equipment

D. Troubleshoot and make minor repairs

E. Match electrodes to base metals

F. Identify the AWS GTAW filler metal classification systems

G. The GTAW process

H. Identify GTAW welding variables and their effects on weld quality

Student Activities:

A. Identify weld variables and plan their input settings and control for quality outcomes

B. Input of variables (setting and controls) for specific welds

C. Make adjustments to GTAW equipment and process to improve weld quality

D. Set up GTAW equipment

E. Perform in process weld inspection

F. Perform in process rework (if required)

G. Discuss weld

WLD-O4-HO2
Identify the Welding Variables and Their Effects Upon Weld Quality
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    a. List advantages and disadvantages of GTAW
    b. List five applications where GTAW or PAW are better suited
    c. List give applications which are more suited to SMAW than GTAW
    d. Compare and contrast GTAW and plasma arc welding (PAC)
    e. List by name the parts of a GTAW torch
    f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 2F position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 3F vertical position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 4F overhead position

    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

   - a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   - b. Cut stainless steel and grind a .30" bevel on edges
   - c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   - d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   - e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
   - a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
   - b. Prepare tungsten for given procedure
   - c. Set up GTAW torch for given procedure
   - d. Set current for procedure
   - e. Adjust shielding gas flow rate
   - f. Weld root using free hand technique and using the walking the cup method
   - g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    - a. Use non-low hydrogen electrodes
    - b. Strike arc and hold long arc length 1" away from last weld crater
    - c. Back-up to previous weld crater holding long arc length
    - d. Pre-heat crater with long arc
    - e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    - a. Use low hydrogen electrodes
    - b. Strike arc 1" from crater
    - c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    - d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    - a. List the names and draw side views of the five basic joint configurations
    - b. List the names and draw side views of the variations of grooves
    - c. List the names and draw side views of the T-Joint variations
    - d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    - a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    - b. Clean bevel face with grinder as required
    - c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

    a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
    b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
    c. List the polarity that air carbon arc is run on
    d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
    e. Connect air carbon torch arc and compressed air hose to welding machine
    f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    a. Locate root of weld
    b. Demonstrate control of depth of cut
    c. Demonstrate control of width of cut
    d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    e. Make gouges of uniform depth
    f. Observe discontinuities as gouging proceeds
    g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    b. Measure to make sure excavation is at proper location and depth
    c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    a. Check area for safety
    b. Set SMAW equipment current and polarity for 1/8" E7018
    c. Attach work lead
    d. Preheat and maintain interpass temperature as required
    e. Weld first pass paying special attention to low hydrogen techniques
    f. Grind the weld start and stop to remove cold lap and lack of fusion
    g. Weld the second pass starting from opposite end
    h. Repeat starts and stops until weld is completed
    i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    a. Check work area for safety
    b. Position steel in a T joint and tack at ends
    c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

Name: ______________________________ Date: ______________________

WLD-O4
Identify the Welding Variables and Their Effects Upon Weld Quality
Self-Assessment

Circle the best answer.

1. Tungsten is a metal with which of the following physical properties?
   - A. High strength and good electrical conductivity
   - B. Highest melting point of any element
   - C. High yield and high ductility
   - D. Low yield, high strength, and good insulation

2. The end of the filler rod must be kept close to the weld zone
   - A. Because it is much easier to see and control
   - B. To prevent it from becoming oxidized
   - C. To keep the rod hot so it melts more easily
   - D. To keep the rod cool to it does not melt

3. The best working temperature for a tungsten is when it is
   - A. Above a white hot temperature
   - B. Below a dull red temperature
   - C. Above a dull red temperature
   - D. Just above room temperature

4. Excessively high shielding gas flow rates can
   - A. Help protect the weld
   - B. Reduce oxide contamination
   - C. Prevent arc blow
   - D. Cause turbulence and poor weld puddle shielding

5. The grinding stone used to shape a tungsten should be
   - A. A fine, hard stone
   - B. Coarse, in order to quickly shape the tungsten
   - C. Used only for tungsten and stainless steels
   - D. Both B and C

6. Why is post-welding gas flow required?
   - A. To protect the hot tungsten from oxidation
   - B. To protect the hot weld metal from oxidation
   - C. To prevent oxides from entering the weld pool
   - D. Both A and B

7. Which tip color is used to identify pure tungsten?
   A. Green
   B. Yellow
   C. Red
   D. Blue

8. Post-weld gas flow time should be
   A. At least 20 seconds
   B. For as long as the weld is hot
   C. Set according to the cup and tungsten sizes used
   D. No longer than needed to protect the tungsten and weld

9. Argon is used as a shield gas with GTAW because argon
   A. Is lighter than air
   B. Allows cathodic cleaning
   C. Produces deep penetration
   D. Prevents electrode waste

10. If the water supply is suddenly shut off, a water cooled GTA welding torch power cable will
   A. Work like an air-cooled torch cable
   B. Automatically stop the current
   C. Rapidly overheat
   D. Have no problem carrying the welding current

WLD-05

WELDER SERIES

MASTER Technical Module No. WLD-O05

SUBJECT: **WELDING TECHNICIAN** **TIME: 8 HOURS**

- **DUTY:** GAS TUNGSTEN ARC WELDING (GTAW) (BASIC)
- **TASK:** Troubleshoot Equipment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide safety tour and orientation to gas tungsten arc welding equipment and accessories, and shielding gas equipment and accessories;

B. Provide demonstrations related to ANSI Z49.1, ***Safety in Welding, Cutting and Allied Processes, Part II - Specific Processes, 11. Arc Welding and Cutting Equipment Safety***

C. Provide demonstrations related to routine safety inspections of protective equipment and clothing, gas tungsten arc welding equipment and accessories, shielding gas equipment and accessories, required tools and the work area

D. Introduce related terms and definitions

E. Observe trainee conducting safety inspections

F. Observe trainee following safe practices

G. Observe trainee using proper terms and definitions

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on Gas Tungsten Arc Welding
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
GTAW equipment
Power supply
Control unit with shielding gas equipment and GTAW air cooled or water cooled torch
Examples of tungsten electrodes
Examples of torch gas nozzles in various sizes and styles
Various types of filler metal rods and wires
Shielding gas regulator, flow meters and accessory equipment
Selected metals for welding exercises
Welding shop tools

MASTER Handout No. 1 (WLD-O5-HO1)
MASTER Handout No. 2 (WLD-O5-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Safety in Welding, Cutting and Allied Processes, Part II – Specific Processes 11, Arc Welding and Cutting Equipment Safety, ANSI Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of GTAW troubleshooting and operator repairs
- A class demonstration safe and productive
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify GTAW equipment

C. Inspection and safe trouble-shooting procedures for all equipment
D. Safety and handling shielding gas mixtures/containers
E. The welding power source configuration
F. How to prevent aspiration of outside atmosphere into the shielding gas
G. Gas flow rates
H. Make minor repairs
I. Electrode diameters and penetration patterns
J. Problems with weld quality related to equipment

Student Activities:

A. Set up GTAW equipment
B. Make adjustments to GTAW equipment and individual techniques to improve weld quality
C. Perform GTAW fillet and groove welds on T fillet and butt-joints on various metals in various positions
D. Perform in process weld inspection
E. Perform in process rework (if required)

PRACTICAL APPLICATION:

The purpose of this module is to assist the student in troubleshooting GTAW equipment to improve skill levels in order to pass any welding test or qualification tests. This module enables the student to setup and troubleshoot GTAW equipment with a high level of confidence.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Procedures will be evaluated by the instructor.

SUMMARY:

GTAW processes and outcomes become predictable after students combine an understanding of variables with continued practice. GTAW has several advantages over other welding processes. It will weld more kinds of metal and metal alloys than any other method. GTAW can also weld some dissimilar metals.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-O6) dealing with describing AWS electrode classification system.

WLD-O5-HO1
Troubleshoot Equipment
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide safety tour and orientation to gas tungsten arc welding equipment and accessories, and shielding gas equipment and accessories;
B. Provide demonstrations related to ANSI Z49.1, ***Safety in Welding, Cutting and Allied Processes, Part II - Specific Processes, 11. Arc Welding and Cutting Equipment Safety***
C. Provide demonstrations related to routine safety inspections of protective equipment and clothing, gas tungsten arc welding equipment and accessories, shielding gas equipment and accessories, required tools and the work area
D. Introduce related terms and definitions
E. Observe trainee conducting safety inspections
F. Observe trainee following safe practices
G. Observe trainee using proper terms and definitions

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify GTAW equipment
C. Inspection and safe trouble-shooting procedures for all equipment
D. Safety and handling shielding gas mixtures/containers
E. The welding power source configuration
F. How to prevent aspiration of outside atmosphere into the shielding gas
G. Gas flow rates
H. Make minor repairs
I. Electrode diameters and penetration patterns
J. Problems with weld quality related to equipment

Student Activities:

A. Set up GTAW equipment
B. Make adjustments to GTAW equipment and individual techniques to improve weld quality
C. Perform GTAW fillet and groove welds on T fillet and butt-joints on various metals in various positions
D. Perform in process weld inspection
E. Perform in process rework (if required)

WLD-O5-HO2
Troubleshoot Equipment
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    a. List advantages and disadvantages of GTAW
    b. List five applications where GTAW or PAW are better suited
    c. List give applications which are more suited to SMAW than GTAW
    d. Compare and contrast GTAW and plasma arc welding (PAC)
    e. List by name the parts of a GTAW torch
    f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 2F position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 3F vertical position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 4F overhead position

    - f. Weld a .050" fillet weld using .045" ER308-L
    - g. Visually inspect joint for burn through, weld size and workmanship
5. Weld on 1/8" Material and 100% Penetration
    - a. Conduct safety inspection of the area and equipment
    - b. Weld on 304 stainless steel
    - c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    - d. Cut stainless steel and grind a .30" bevel on edges
    - e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    - f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    - g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    - a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    - b. Cut stainless steel and grind a .30" bevel on edges
    - c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    - d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    - e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    - a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    - b. Cut stainless steel and grind a .30" bevel on edges
    - c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    - d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    - e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten.
b. Cut stainless steel and grind a .30" bevel on edges
c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
   a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
   b. Prepare tungsten for given procedure
   c. Set up GTAW torch for given procedure
   d. Set current for procedure
   e. Adjust shielding gas flow rate
   f. Weld root using free hand technique and using the walking the cup method
   g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
   a. Use non-low hydrogen electrodes
   b. Strike arc and hold long arc length 1" away from last weld crater
   c. Back-up to previous weld crater holding long arc length
   d. Pre-heat crater with long arc
   e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
   a. Use low hydrogen electrodes
   b. Strike arc 1" from crater
   c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
   d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
   a. List the names and draw side views of the five basic joint configurations
   b. List the names and draw side views of the variations of grooves
   c. List the names and draw side views of the T-Joint variations
   d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
   a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
   b. Clean bevel face with grinder as required
   c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

- a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
- b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
- c. List the polarity that air carbon arc is run on
- d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
- e. Connect air carbon torch arc and compressed air hose to welding machine
- f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    - a. Locate root of weld
    - b. Demonstrate control of depth of cut
    - c. Demonstrate control of width of cut
    - d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    - e. Make gouges of uniform depth
    - f. Observe discontinuities as gouging proceeds
    - g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    - a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    - b. Measure to make sure excavation is at proper location and depth
    - c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    - d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    - a. Check area for safety
    - b. Set SMAW equipment current and polarity for 1/8" E7018
    - c. Attach work lead
    - d. Preheat and maintain interpass temperature as required
    - e. Weld first pass paying special attention to low hydrogen techniques
    - f. Grind the weld start and stop to remove cold lap and lack of fusion
    - g. Weld the second pass starting from opposite end
    - h. Repeat starts and stops until weld is completed
    - i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    - a. Check work area for safety
    - b. Position steel in a T joint and tack at ends
    - c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    - d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    - e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

Name: ________________________________ Date: ______________________

WLD-O5
Troubleshoot Equipment
Self-Assessment

Circle the best answer.

1. Tungsten is a metal with which of the following physical properties?
   - A. High strength and good electrical conductivity
   - B. Highest melting point of any element
   - C. High yield and high ductility
   - D. Low yield, high strength, and good insulation

2. The end of the filler rod must be kept close to the weld zone
   - A. Because it is much easier to see and control
   - B. To prevent it from becoming oxidized
   - C. To keep the rod hot so it melts more easily
   - D. To keep the rod cool to it does not melt

3. The best working temperature for a tungsten is when it is
   - A. Above a white hot temperature
   - B. Below a dull red temperature
   - C. Above a dull red temperature
   - D. Just above room temperature

4. Excessively high shielding gas flow rates can
   - A. Help protect the weld
   - B. Reduce oxide contamination
   - C. Prevent arc blow
   - D. Cause turbulence and poor weld puddle shielding

5. The grinding stone used to shape a tungsten should be
   - A. A fine, hard stone
   - B. Coarse, in order to quickly shape the tungsten
   - C. Used only for tungsten and stainless steels
   - D. Both B and C

6. Why is post-welding gas flow required?
   - A. To protect the hot tungsten from oxidation
   - B. To protect the hot weld metal from oxidation
   - C. To prevent oxides from entering the weld pool
   - D. Both A and B

7. Which tip color is used to identify pure tungsten?
   A. Green
   B. Yellow
   C. Red
   D. Blue

8. Post-weld gas flow time should be
   A. At least 20 seconds
   B. For as long as the weld is hot
   C. Set according to the cup and tungsten sizes used
   D. No longer than needed to protect the tungsten and weld

9. Argon is used as a shield gas with GTAW because argon
   A. Is lighter than air
   B. Allows cathodic cleaning
   C. Produces deep penetration
   D. Prevents electrode waste

10. If the water supply is suddenly shut off, a water cooled GTA welding torch power cable will
    A. Work like an air-cooled torch cable
    B. Automatically stop the current
    C. Rapidly overheat
    D. Have no problem carrying the welding current

WELDER SERIES
MASTER Technical Module No. WLD-O06

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **GAS TUNGSTEN ARC WELDING (GTAW) (BASIC)**
- **TASK:** Describe AWS Electrode Classification System

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand AWS Electrode Classification System; and,
B. Understand "filler metal to parent metal" compatibility.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on AWS Electrode Classification System
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
GTAW equipment
Power supply
Control unit with shielding gas equipment and GTAW air cooled or water cooled torch
Examples of tungsten electrodes
Examples of torch gas nozzles in various sizes and styles
Various types of filler metal rods and wires
Shielding gas regulator, flow meters and accessory equipment
Selected metals for welding exercises
Welding shop tools
MASTER Handout No. 1 (WLD-O6-HO1)
MASTER Handout No. 2 (WLD-O6-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

Recommended Practices for Gas Tungsten Arc Welding, AWS Welding Handbook, Volume 1, Latest Edition

Welding Technology, Chapter 4, Welding Metallurgy, ANSI/AWS A5/18, American Welding Society, Miami, FL, Latest Edition

Specification for Carbon Steel Filler Metals for Gas Shielded Arc Welding, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition

Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.9, American Welding Society, Miami, FL, Latest Edition

Specification for Bare Stainless Steel Electrodes and Rods, ANSI/AWS A5.12, American Welding Society, Miami, FL, Latest Edition

Specification for Tungsten and Tungsten Alloy Electrodes for Arc Welding and Cutting, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the AWS Electrode Classification System
- A class demonstration of the selection process for filler metals
- A discussion on methods leading to an increase of skill and knowledge

---

PRESENTATION OUTLINE:

Instructional Topics:

A. Summary of safety precautions

B. Describe the AWS Electrode Classification System

C. Identify the importance and variations of shielding gas mixtures and filler metal

D. Identify GTAW equipment
E. Types of "non-consumable" tungsten electrodes
F. Describe the possible effects on weld quality of electrode selection
G. Identify resources for research on metallurgy and metals compatibility
H. Describe Classification Systems information available from professional sources and government sources
I. Describe Library/computer software/internet resource materials

Student Activities:

A. Understand the purpose of metals classification and proper filler metal selection
B. Prepare GTAW equipment with various tungsten electrodes
C. Make adjustments to GTAW equipment and process to improve weld quality
D. Select the weld materials required based on job requirements or specification
E. Perform weld inspection following use of different sized electrodes

---

PRACTICAL APPLICATION:

This module provides information and practice with various tungsten electrodes and filler metals. A general discussion and practical exercise on sources of compatibility information will follow.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Students will perform a compatibility exercise by selecting weld materials based upon job requirements or specification.

SUMMARY:

The purpose of this module is to assist the student in the use of the AWS electrode classification system, as it applies to GTAW.

The tungsten electrode is non-consumable and is not intended to become part of the filler metal in the weld deposit (unless tungsten base metal is used). Tungsten has the highest melting point of any of the metals (6170 degrees F)

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-O7) dealing with describing AWS filler metal classification system.

WLD-O6-HO1
Describe AWS Electrode Classification System
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand AWS Electrode Classification System; and,

B. Understand "filler metal to parent metal" compatibility.

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions

B. Describe the AWS Electrode Classification System

C. Identify the importance and variations of shielding gas mixtures and filler metal

D. Identify GTAW equipment

E. Types of "non-consumable" tungsten electrodes

F. Describe the possible effects on weld quality of electrode selection

G. Identify resources for research on metallurgy and metals compatibility

H. Describe Classification Systems information available from professional sources and government sources

I. Describe Library/computer software/internet resource materials

Student Activities:

A. Understand the purpose of metals classification and proper filler metal selection

B. Prepare GTAW equipment with various tungsten electrodes

C. Make adjustments to GTAW equipment and process to improve weld quality

D. Select the weld materials required based on job requirements or specification

E. Perform weld inspection following use of different sized electrodes

WLD-O6-HO2

Describe AWS Electrode Classification System

Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    a. List advantages and disadvantages of GTAW
    b. List five applications where GTAW or PAW are better suited
    c. List give applications which are more suited to SMAW than GTAW
    d. Compare and contrast GTAW and plasma arc welding (PAC)
    e. List by name the parts of a GTAW torch
    f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 2F position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 3F vertical position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 4F overhead position

   f. Weld a .050" fillet weld using .045" ER308-L
   g. Visually inspect joint for burn through, weld size and workmanship
5. Weld on 1/8" Material and 100% Penetration
   a. Conduct safety inspection of the area and equipment
   b. Weld on 304 stainless steel
   c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   d. Cut stainless steel and grind a .30" bevel on edges
   e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
   a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   b. Cut stainless steel and grind a .30" bevel on edges
   c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
   a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   b. Cut stainless steel and grind a .30" bevel on edges
   c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

- a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
- b. Cut stainless steel and grind a .30" bevel on edges
- c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
- d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
- e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
    - a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
    - b. Prepare tungsten for given procedure
    - c. Set up GTAW torch for given procedure
    - d. Set current for procedure
    - e. Adjust shielding gas flow rate
    - f. Weld root using free hand technique and using the walking the cup method
    - g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    - a. Use non-low hydrogen electrodes
    - b. Strike arc and hold long arc length 1" away from last weld crater
    - c. Back-up to previous weld crater holding long arc length
    - d. Pre-heat crater with long arc
    - e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    - a. Use low hydrogen electrodes
    - b. Strike arc 1" from crater
    - c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    - d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    - a. List the names and draw side views of the five basic joint configurations
    - b. List the names and draw side views of the variations of grooves
    - c. List the names and draw side views of the T-Joint variations
    - d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    - a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    - b. Clean bevel face with grinder as required
    - c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

- a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
  - b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
  - c. List the polarity that air carbon arc is run on
  - d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
  - e. Connect air carbon torch arc and compressed air hose to welding machine
  - f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    - a. Locate root of weld
    - b. Demonstrate control of depth of cut
    - c. Demonstrate control of width of cut
    - d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    - e. Make gouges of uniform depth
    - f. Observe discontinuities as gouging proceeds
    - g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    - a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    - b. Measure to make sure excavation is at proper location and depth
    - c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    - d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    - a. Check area for safety
    - b. Set SMAW equipment current and polarity for 1/8" E7018
    - c. Attach work lead
    - d. Preheat and maintain interpass temperature as required
    - e. Weld first pass paying special attention to low hydrogen techniques
    - f. Grind the weld start and stop to remove cold lap and lack of fusion
    - g. Weld the second pass starting from opposite end
    - h. Repeat starts and stops until weld is completed
    - i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    - a. Check work area for safety
    - b. Position steel in a T joint and tack at ends
    - c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    - d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    - e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

Name: ______________________________ Date: ____________________

WLD-O6
Describe AWS Electrode Classification System
Self-Assessment

Circle the best answer.

1. Tungsten is a metal with which of the following physical properties?
   - A. High strength and good electrical conductivity
   - B. Highest melting point of any element
   - C. High yield and high ductility
   - D. Low yield, high strength, and good insulation

2. The end of the filler rod must be kept close to the weld zone
   - A. Because it is much easier to see and control
   - B. To prevent it from becoming oxidized
   - C. To keep the rod hot so it melts more easily
   - D. To keep the rod cool to it does not melt

3. The best working temperature for a tungsten is when it is
   - A. Above a white hot temperature
   - B. Below a dull red temperature
   - C. Above a dull red temperature
   - D. Just above room temperature

4. Excessively high shielding gas flow rates can
   - A. Help protect the weld
   - B. Reduce oxide contamination
   - C. Prevent arc blow
   - D. Cause turbulence and poor weld puddle shielding

5. The grinding stone used to shape a tungsten should be
   - A. A fine, hard stone
   - B. Coarse, in order to quickly shape the tungsten
   - C. Used only for tungsten and stainless steels
   - D. Both B and C

6. Why is post-welding gas flow required?
   - A. To protect the hot tungsten from oxidation
   - B. To protect the hot weld metal from oxidation
   - C. To prevent oxides from entering the weld pool
   - D. Both A and B

7. Which tip color is used to identify pure tungsten?
   A. Green
   B. Yellow
   C. Red
   D. Blue

8. Post-weld gas flow time should be
   A. At least 20 seconds
   B. For as long as the weld is hot
   C. Set according to the cup and tungsten sizes used
   D. No longer than needed to protect the tungsten and weld

9. Argon is used as a shield gas with GTAW because argon
   A. Is lighter than air
   B. Allows cathodic cleaning
   C. Produces deep penetration
   D. Prevents electrode waste

10. If the water supply is suddenly shut off, a water cooled GTA welding torch power cable will
   A. Work like an air-cooled torch cable
   B. Automatically stop the current
   C. Rapidly overheat
   D. Have no problem carrying the welding current

WLD-07

WELDER SERIES

MASTER Technical Module No. WLD-O07

SUBJECT: WELDING TECHNICIAN **TIME:** 4 HOURS

- **DUTY:** GAS TUNGSTEN ARC WELDING (GTAW) (BASIC)
- **TASK:** Describe AWS Filler Metal Classification System

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand compatibility of filler metal to parent metal; and,
B. Use the AWS Filler Metal Classification System.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on filler metals for Gas Tungsten Arc Welding
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
GTAW equipment
Power supply
Control unit with shielding gas equipment and GTAW air cooled or water cooled Torch
Various types of filler metal rods and wires
Examples of tungsten electrodes
Examples of torch gas nozzles in various sizes and styles
Shielding gas regulator, flow meters and accessory equipment
Selected metals for welding exercises
Welding shop tools
MASTER Handout No. 1 (WLD-O7-HO1)
MASTER Handout No. 2 (WLD-O7-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Gas Tungsten Arc Welding, AWS Welding Handbook, Volume 1, Latest Edition
Welding Technology, Chapter 4, Welding Metallurgy, ANSI/AWS A5/18, American Welding Society, Miami, FL, Latest Edition
Specification for Carbon Steel Filler Metals for Gas Shielded Arc Welding, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.9, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Stainless Steel Electrodes and Rods, ANSI/AWS A5.12, American Welding Society, Miami, FL, Latest Edition
Specification for Tungsten and Tungsten Alloy Electrodes for Arc Welding and Cutting, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the AWS filler metal classification system
- A discussion of capability issues

PRESENTATION OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Discuss shielding gas and filler metal selection
C. Identify the AWS GTAW filler metal classification systems
D. Identify GTAW equipment and the process of introducing the use of filler metal

E. Identify the effects of filler metal on weld quality
F. Metallurgy and metals characteristics of most popular metals

Student Activities:
A. Set up GTAW equipment
B. Use AWS filler metal alloy charts
C. Perform in process weld inspection
D. Make adjustments to GTAW equipment and process to improve weld quality
E. Perform in process rework (if required)

PRACTICAL APPLICATION:

The purpose of this module is to assist the student in the use of the AWS filler metal classification system. This lesson will be a study on AWS filler metals, alloys, and related variable weld characteristics. The GTAW process can be implemented with or without a filler metal. When it is used, it is added to the weld pool from a separate rod or wire, being melted by the heat of the arc rather than transferred across the arc as in the consumable electrode arc weld processes. Its most common applications are for aluminum and stainless steel.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Students will explain compatibility issues, use of filler metals, and metals characteristics that require special preparation and treatment.

SUMMARY:

Students should have a thorough knowledge of the AWS filler metal classification system and be capable in researching metals characteristics influencing the weld quality, metal preparation, and preheat.

Tungsten is employed as a non-consumable electrode in the gas tungsten arc welding process, the plasma welding process, and the plasma cutting process. The addition of thoria and zirconia was originally intended to promote better arc starting in tungsten electrodes and it was found that up to 0.6 thoria would increase carrying capabilities. Most porous weld structures are caused by moisture in the electrode covering. To minimize this condition, the electrodes are supplied in moisture-proof packages. The electrodes should be stored in a dry location. Deterioration of the flux covering can be rapid when electrodes are exposed to moist air. The entire covering can be affected in only a few hours of exposure to a humid atmosphere.

The best quality welds are obtained by using welding wire as soon as possible after it is removed from the package. Even a high quality wire can produce welds of inferior quality if the wire surface is exposed to high humidity.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-O8) dealing with performing GTAW fillet and groove welds on T and butt joints on various metals in various positions.

WLD-O7-HO1

Describe AWS Filler Metal Classification System

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand compatibility of filler metal to parent metal; and,

B. Use the AWS Filler Metal Classification System.

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions

B. Discuss shielding gas and filler metal selection

C. Identify the AWS GTAW filler metal classification systems

D. Identify GTAW equipment and the process of introducing the use of filler metal

E. Identify the effects of filler metal on weld quality

F. Metallurgy and metals characteristics of most popular metals

Student Activities:

A. Set up GTAW equipment

B. Use AWS filler metal alloy charts

C. Perform in process weld inspection

D. Make adjustments to GTAW equipment and process to improve weld quality

E. Perform in process rework (if required)

WLD-O7-HO2

Describe AWS Filler Metal Classification System

Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    a. List advantages and disadvantages of GTAW
    b. List five applications where GTAW or PAW are better suited
    c. List give applications which are more suited to SMAW than GTAW
    d. Compare and contrast GTAW and plasma arc welding (PAC)
    e. List by name the parts of a GTAW torch
    f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 2F position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 3F vertical position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 4F overhead position

    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver

7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver

8. Weld 4G Position Using GTAW

    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
    a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
    b. Prepare tungsten for given procedure
    c. Set up GTAW torch for given procedure
    d. Set current for procedure
    e. Adjust shielding gas flow rate
    f. Weld root using free hand technique and using the walking the cup method
    g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    a. Use non-low hydrogen electrodes
    b. Strike arc and hold long arc length 1" away from last weld crater
    c. Back-up to previous weld crater holding long arc length
    d. Pre-heat crater with long arc
    e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    a. Use low hydrogen electrodes
    b. Strike arc 1" from crater
    c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    a. List the names and draw side views of the five basic joint configurations
    b. List the names and draw side views of the variations of grooves
    c. List the names and draw side views of the T-Joint variations
    d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    b. Clean bevel face with grinder as required
    c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

    a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
    b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
    c. List the polarity that air carbon arc is run on
    d Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
    e. Connect air carbon torch arc and compressed air hose to welding machine
    f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    a. Locate root of weld
    b. Demonstrate control of depth of cut
    c. Demonstrate control of width of cut
    d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    e. Make gouges of uniform depth
    f. Observe discontinuities as gouging proceeds
    g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    b. Measure to make sure excavation is a proper location and depth
    c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    a. Check area for safety
    b. Set SMAW equipment current and polarity for 1/8" E7018
    c. Attach work lead
    d. Preheat and maintain interpass temperature as required
    e. Weld first pass paying special attention to low hydrogen techniques
    f. Grind the weld start and stop to remove cold lap and lack of fusion
    g. Weld the second pass starting from opposite end
    h. Repeat starts and stops until weld is completed
    i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    a. Check work area for safety
    b. Position steel in a T joint and tack at ends
    c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

Name: ______________________________ Date: ____________________

WLD-O7
Describe AWS Filler Metal Classification System
Self-Assessment

Circle the best answer.

1. Tungsten is a metal with which of the following physical properties?
   - A. High strength and good electrical conductivity
   - B. Highest melting point of any element
   - C. High yield and high ductility
   - D. Low yield, high strength, and good insulation

2. The end of the filler rod must be kept close to the weld zone
   - A. Because it is much easier to see and control
   - B. To prevent it from becoming oxidized
   - C. To keep the rod hot so it melts more easily
   - D. To keep the rod cool to it does not melt

3. The best working temperature for a tungsten is when it is
   - A. Above a white hot temperature
   - B. Below a dull red temperature
   - C. Above a dull red temperature
   - D. Just above room temperature

4. Excessively high shielding gas flow rates can
   - A. Help protect the weld
   - B. Reduce oxide contamination
   - C. Prevent arc blow
   - D. Cause turbulence and poor weld puddle shielding

5. The grinding stone used to shape a tungsten should be
   - A. A fine, hard stone
   - B. Coarse, in order to quickly shape the tungsten
   - C. Used only for tungsten and stainless steels
   - D. Both B and C

6. Why is post-welding gas flow required?
   - A. To protect the hot tungsten from oxidation
   - B. To protect the hot weld metal from oxidation
   - C. To prevent oxides from entering the weld pool
   - D. Both A and B

7. Which tip color is used to identify pure tungsten?
   - A. Green
   - B. Yellow
   - C. Red
   - D. Blue

8. Post-weld gas flow time should be
   - A. At least 20 seconds
   - B. For as long as the weld is hot
   - C. Set according to the cup and tungsten sizes used
   - D. No longer than needed to protect the tungsten and weld

9. Argon is used as a shield gas with GTAW because argon
   - A. Is lighter than air
   - B. Allows cathodic cleaning
   - C. Produces deep penetration
   - D. Prevents electrode waste

10. If the water supply is suddenly shut off, a water cooled GTA welding torch power cable will
    - A. Work like an air-cooled torch cable
    - B. Automatically stop the current
    - C. Rapidly overheat
    - D. Have no problem carrying the welding current

WELDER SERIES

MASTER Technical Module No. WLD-O08

SUBJECT: WELDING TECHNICIAN **TIME: 12 HOURS**

- **DUTY:** **GAS TUNGSTEN ARC WELDING (GTAW) (BASIC)**
- **TASK:** Perform GTAW Fillet and Groove Welds on T and Butt Joints on Various Metals in Various Positions

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform gas tungsten arc welding equipment operations;
B. Understand gas tungsten arc welding principles of operations;
C. Understand and control common process variables for gas tungsten arc welding;
D. Start and maintain an arc on plain carbon steel, using applicable filler metal and shielding gas;
E. Start and maintain an arc on aluminum, using applicable filler metal and shielding gas;
F. Start and maintain an arc on stainless steel, using applicable filler metal and shielding gas;
G. Perform flat, single pass, surfacing welds, on plain carbon steel, using applicable filler metal and shielding gas;
H. Perform flat, single pass, surfacing welds, on aluminum, using applicable filler metal and shielding gas;
I. Perform flat, single pass, surfacing welds, on stainless steel, using applicable filler metal and shielding gas; and,
J. Following safe GTAW practices.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on Gas Tungsten Arc Welding
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
GTAW equipment
Power supply
Control unit with shielding gas equipment and GTAW air cooled or water cooled torch

Examples of tungsten electrodes
Examples of torch gas nozzles in various sizes and styles
Various types of filler metal rods
Shielding gas regulator, flow meters and accessory equipment
Selected metals for welding exercises
Welding shop tools
MASTER Handout No. 1 (WLD-O8-HO1)
MASTER Handout No. 2 (WLD-O8-HO2)
MASTER Self-Assessment

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Gas Tungsten Arc Welding, AWS Welding Handbook, Volume 1, Latest Edition
Welding Technology, Chapter 4, Welding Metallurgy, ANSI/AWS A5/18, American Welding Society, Miami, FL, Latest Edition
Specification for Carbon Steel Filler Metals for Gas Shielded Arc Welding, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.9, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Stainless Steel Electrodes and Rods, ANSI/AWS A5.12, American Welding Society, Miami, FL, Latest Edition
Specification for Tungsten and Tungsten Alloy Electrodes for Arc Welding and Cutting, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of GTAW weld sequence
- A class demonstration of effective welding techniques and control of variables
- A discussion on methods leading to an increase of skill and knowledge

PRESENTATION OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Identify the AWS GTAW filler metal classification systems
D. Identify GTAW welding variables and their effects on weld quality
E. Match electrodes or filler metals to base metals
F. Use GTAW equipment in a safe and effective manner
G. Troubleshoot and make minor repairs

Student Activities:

A. Set up GTAW equipment for welding
B. Make adjustments to GTAW equipment and process to improve weld quality
C. Perform GTAW fillet and groove welds on T fillet and butt-joints on various metals in various positions
D. Perform in process weld inspection
E. Perform in process rework (if required)
F. Perform other weld exercises in student handbook as recommended by instructor

PRACTICAL APPLICATION:

This module will provide the student practice using various electrodes and filler metals in typical professional welding assignments.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Each weld will be inspected and evaluated in accordance with AWS Standards.

SUMMARY:

GTAW processes can provide high quality welds, contingent upon skill, planning, and intelligent use of materials of the operator/welder. GTAW will weld more kinds of metals and metal alloys than any other welding method. It also produces little or no spatter. There is no requirement for flux in this process and no slag deposits to remove.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-O9) dealing with passing a performance qualification test using GTAW on carbon steel in the 6G position on pipe.

WLD-O8-HO1

Perform GTAW Fillet and Groove Welds on T and Butt Joints On Various Metals in Various Positions

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform gas tungsten arc welding equipment operations;
B. Understand gas tungsten arc welding principles of operations;
C. Understand and control common process variables for gas tungsten arc welding;
D. Start and maintain an arc on plain carbon steel, using applicable filler metal and shielding gas;
E. Start and maintain an arc on aluminum, using applicable filler metal and shielding gas;
F. Start and maintain an arc on stainless steel, using applicable filler metal and shielding gas;
G. Perform flat, single pass, surfacing welds, on plain carbon steel, using applicable filler metal and shielding gas;
H. Perform flat, single pass, surfacing welds, on aluminum, using applicable filler metal and shielding gas;
I. Perform flat, single pass, surfacing welds, on stainless steel, using applicable filler metal and shielding gas; and,
J. Following safe GTAW practices.

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Identify the AWS GTAW filler metal classification systems
D. Identify GTAW welding variables and their effects on weld quality
E. Match electrodes or filler metals to base metals
F. Use GTAW equipment in a safe and effective manner
G. Troubleshoot and make minor repairs

Student Activities:

A. Set up GTAW equipment for welding
B. Make adjustments to GTAW equipment and process to improve weld quality
C. Perform GTAW fillet and groove welds on T fillet and butt-joints on various metals in various positions
D. Perform in process weld inspection
E. Perform in process rework (if required)

F. Perform other weld exercises in student handbook as recommended by instructor

WLD-O8-HO2
Perform GTAW Fillet and Groove Welds on T and Butt Joints On Various Metals in Various Positions
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    - a. List advantages and disadvantages of GTAW
    - b. List five applications where GTAW or PAW are better suited
    - c. List give applications which are more suited to SMAW than GTAW
    - d. Compare and contrast GTAW and plasma arc welding (PAC)
    - e. List by name the parts of a GTAW torch
    - f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    - g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    - a. Conduct safety inspection of the area and equipment
    - b. Weld on 304 stainless steel
    - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    - d. Cut stainless steel to .050" X 2" X 10"
    - e. Fit up and tack a T joint and place in the 2F position
    - f. Weld a .050" fillet weld using .045" ER308-L
    - g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    - a. Conduct safety inspection of the area and equipment
    - b. Weld on 304 stainless steel
    - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    - d. Cut stainless steel to .050" X 2" X 10"
    - e. Fit up and tack a T joint and place in the 3F vertical position
    - f. Weld a .050" fillet weld using .045" ER308-L
    - g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    - a. Conduct safety inspection of the area and equipment
    - b. Weld on 304 stainless steel
    - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    - d. Cut stainless steel to .050" X 2" X 10"

- e. Fit up and tack a T joint and place in the 4F overhead position
- f. Weld a .050" fillet weld using .045" ER308-L
- g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   - d. Cut stainless steel and grind a .30" bevel on edges
   - e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   - f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   - g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
   - a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   - b. Cut stainless steel and grind a .30" bevel on edges
   - c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   - d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   - e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
   - a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   - b. Cut stainless steel and grind a .30" bevel on edges
   - c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   - d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   - e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
b. Cut stainless steel and grind a .30" bevel on edges
c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
    a Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
    b Prepare tungsten for given procedure
    c Set up GTAW torch for given procedure
    d Set current for procedure
    e Adjust shielding gas flow rate
    f Weld root using free hand technique and using the walking the cup method
    g Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    a Use non-low hydrogen electrodes
    b Strike arc and hold long arc length 1" away from last weld crater
    c Back-up to previous weld crater holding long arc length
    d Pre-heat crater with long arc
    e Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    a Use low hydrogen electrodes
    b Strike arc 1" from crater
    c Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    d Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    a List the names and draw side views of the five basic joint configurations
    b List the names and draw side views of the variations of grooves
    c List the names and draw side views of the T-Joint variations
    d List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    a Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    b. Clean bevel face with grinder as required
    c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

   a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
   b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
   c. List the polarity that air carbon arc is run on
   d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
   e. Connect air carbon torch arc and compressed air hose to welding machine
   f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
   a. Locate root of weld
   b. Demonstrate control of depth of cut
   c. Demonstrate control of width of cut
   d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
   e. Make gouges of uniform depth
   f. Observe discontinuities as gouging proceeds
   g. Gouge until some weld metal is reached

16. Gouge to Excavate Defect
   a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
   b. Measure to make sure excavation is at proper location and depth
   c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
   d. Clean area of all scale, carbon etc.

17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
   a. Check area for safety
   b. Set SMAW equipment current and polarity for 1/8" E7018
   c. Attach work lead
   d. Preheat and maintain interpass temperature as required
   e. Weld first pass paying special attention to low hydrogen techniques
   f. Grind the weld start and stop to remove cold lap and lack of fusion
   g. Weld the second pass starting from opposite end
   h. Repeat starts and stops until weld is completed
   i. Inspect and submit for non-destructive testing RT or UT

18. Produce Fillet Weld on Sheet Steel T Joints
   a. Check work area for safety
   b. Position steel in a T joint and tack at ends
   c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
   d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
   e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

Name: ________________________________ Date: ______________________

WLD-O8
Perform GTAW Fillet and Groove Welds on T and Butt Joints On Various Metals in Various Positions Self-Assessment

Circle the best answer.

1. Tungsten is a metal with which of the following physical properties?
   A. High strength and good electrical conductivity
   B. Highest melting point of any element
   C. High yield and high ductility
   D. Low yield, high strength, and good insulation

2. The end of the filler rod must be kept close to the weld zone
   A. Because it is much easier to see and control
   B. To prevent it from becoming oxidized
   C. To keep the rod hot so it melts more easily
   D. To keep the rod cool to it does not melt

3 The best working temperature for a tungsten is when it is
   A. Above a white hot temperature
   B. Below a dull red temperature
   C. Above a dull red temperature
   D. Just above room temperature

4 Excessively high shielding gas flow rates can
   A. Help protect the weld
   B. Reduce oxide contamination
   C. Prevent arc blow
   D. Cause turbulence and poor weld puddle shielding

5. The grinding stone used to shape a tungsten should be
   A. A fine, hard stone
   B. Coarse, in order to quickly shape the tungsten
   C. Used only for tungsten and stainless steels
   D. Both B and C

6. Why is post-welding gas flow required?
   A. To protect the hot tungsten from oxidation
   B. To protect the hot weld metal from oxidation
   C. To prevent oxides from entering the weld pool
   D. Both A and B

7. Which tip color is used to identify pure tungsten?
   - A. Green
   - B. Yellow
   - C. Red
   - D. Blue

8. Post-weld gas flow time should be
   - A. At least 20 seconds
   - B. For as long as the weld is hot
   - C. Set according to the cup and tungsten sizes used
   - D. No longer than needed to protect the tungsten and weld

9. Argon is used as a shield gas with GTAW because argon
   - A. Is lighter than air
   - B. Allows cathodic cleaning
   - C. Produces deep penetration
   - D. Prevents electrode waste

10. If the water supply is suddenly shut off, a water cooled GTA welding torch power cable will
    - A. Work like an air-cooled torch cable
    - B. Automatically stop the current
    - C. Rapidly overheat
    - D. Have no problem carrying the welding current

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

	Duties	Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and [illegible] T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

[illegible]

1081

1080

Duty O2

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
M2 GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3 GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on lilfe of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1 Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2 Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-09

WELDER SERIES

MASTER Technical Module No. WLD-O09

SUBJECT: **WELDING TECHNICIAN** **TIME: 10 HOURS**

- **DUTY:** **GAS TUNGSTEN ARC WELDING (GTAW) (ADVANCED)**
- **TASK:** Pass a Performance Qualification Test Using GTAW on Carbon Steel in the 6G Position on Pipe

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Set-up welding area and equipment;
B. Set-up work piece and purge gas; and,
C. Weld test piece according to specifications.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on Gas Tungsten Arc Welding
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
GTAW equipment
Power supply
Control unit with shielding gas equipment and GTAW air cooled or water cooled torch
Examples of tungsten electrodes
Examples of torch gas nozzles in various sizes and styles
Various types of filler metal rods and wires
Shielding gas regulator, flow meters and accessory equipment
Selected metals for welding exercises
Welding shop tools
MASTER Handout No. 1 (WLD-O9-HO1)
MASTER Handout No. 2 (WLD-O9-HO2)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Gas Tungsten Arc Welding, AWS Welding Handbook, Volume 1, Latest Edition
Welding Technology, Chapter 4, Welding Metallurgy, ANSI/AWS A5/18, American Welding Society, Miami, FL, Latest Edition
Specification for Carbon Steel Filler Metals for Gas Shielded Arc Welding, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.9, American Welding Society, Miami, FL, Latest Edition
Specification for Bare Stainless Steel Electrodes and Rods, ANSI/AWS A5.12, American Welding Society, Miami, FL, Latest Edition
Specification for Tungsten and Tungsten Alloy Electrodes for Arc Welding and Cutting, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the versatility of GTAW applications
- A discussion on methods leading to an increase of skill and knowledge in pipe welding applications

PRESENTATION OUTLINE:

Instructional Topics:

- A. Summary of safety precautions
- B. Identify the importance and variations of shielding gas mixtures
- C. Identify GTAW equipment
- D. Identify GTAW welding variables and their effects on weld quality with carbon steel pipe
- E. Use GTAW to weld carbon steel in the 6G position on pipe

Student Activities:

- A. Set up GTAW equipment
- B. Perform welding process prescribed in the 6G position on pipe
- C. Perform in process weld inspection
- D. Perform in process rework (if required)
- E. Perform other weld exercises in the student handbook, as may be assigned by the instructor

PRACTICAL APPLICATION:

This module will assist the student increasing knowledge and skill in GTAW processes for pipe welding

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Each weld will also be inspected and evaluated by the student and the instructor.

SUMMARY:

The purpose of this module is to prepare the student to use GTAW in welding carbon steel pipe. Performance qualification tests are necessary to verify professional level quality by welders. Qualification in the 6G (pipe axis inclined, fixed) position qualifies for all position fillet welding of plate and pipe and all position groove welding of plate and pipe, except for T-, V-, and K- connections.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-O10) dealing with passing a performance qualification test using GTAW on aluminum in the 6G position on pipe.

WLD-O9-HO1
Pass a Performance Qualification Test Using GTAW On Carbon Steel in the 6G Position on Pipe
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Set-up welding area and equipment;
B. Set-up work piece and purge gas; and,
C. Weld test piece according to specifications.

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Identify GTAW equipment
D. Identify GTAW welding variables and their effects on weld quality with carbon steel pipe
E. Use GTAW to weld carbon steel in the 6G position on pipe

Student Activities:

A. Set up GTAW equipment
B. Perform welding process prescribed in the 6G position on pipe
C. Perform in process weld inspection
D. Perform in process rework (if required)
E. Perform other weld exercises in the student handbook, as may be assigned by the instructor

WLD-O9-HO2
Pass a Performance Qualification Test Using GTAW
On Carbon Steel in the 6G Position on Pipe
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
   - a. List advantages and disadvantages of GTAW
   - b. List five applications where GTAW or PAW are better suited
   - c. List give applications which are more suited to SMAW than GTAW
   - d. Compare and contrast GTAW and plasma arc welding (PAC)
   - e. List by name the parts of a GTAW torch
   - f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
   - g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 2F position
   - f. Weld a .050" fillet weld using .045" ER308-L
   - g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 3F vertical position
   - f. Weld a .050" fillet weld using .045" ER308-L
   - g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"

    e. Fit up and tack a T joint and place in the 4F overhead position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

- a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
- b. Cut stainless steel and grind a .30" bevel on edges
- c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
- d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
- e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
   - a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
   - b. Prepare tungsten for given procedure
   - c. Set up GTAW torch for given procedure
   - d. Set current for procedure
   - e. Adjust shielding gas flow rate
   - f. Weld root using free hand technique and using the walking the cup method
   - g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    - a. Use non-low hydrogen electrodes
    - b. Strike arc and hold long arc length 1" away from last weld crater
    - c. Back-up to previous weld crater holding long arc length
    - d. Pre-heat crater with long arc
    - e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    - a. Use low hydrogen electrodes
    - b. Strike arc 1" from crater
    - c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    - d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    - a. List the names and draw side views of the five basic joint configurations
    - b. List the names and draw side views of the variations of grooves
    - c. List the names and draw side views of the T-Joint variations
    - d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    - a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    - b. Clean bevel face with grinder as required
    - c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
c. List the polarity that air carbon arc is run on
d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
e. Connect air carbon torch arc and compressed air hose to welding machine
f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    a. Locate root of weld
    b. Demonstrate control of depth of cut
    c. Demonstrate control of width of cut
    d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    e. Make gouges of uniform depth
    f. Observe discontinuities as gouging proceeds
    g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    b. Measure to make sure excavation is at proper location and depth
    c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    a. Check area for safety
    b. Set SMAW equipment current and polarity for 1/8" E7018
    c. Attach work lead
    d. Preheat and maintain interpass temperature as required
    e. Weld first pass paying special attention to low hydrogen techniques
    f. Grind the weld start and stop to remove cold lap and lack of fusion
    g. Weld the second pass starting from opposite end
    h. Repeat starts and stops until weld is completed
    i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    a. Check work area for safety
    b. Position steel in a T joint and tack at ends
    c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

WELDER SERIES

MASTER Technical Module No. WLD-O10

SUBJECT: WELDING TECHNICIAN TIME: 10 HOURS

- **DUTY:** **GAS TUNGSTEN ARC WELDING (GTAW) (ADVANCED)**
- **TASK:** Pass a Performance Qualification Test Using GTAW on Aluminum in the 6G Position on Pipe

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Set-up welding area and equipment;
B. Set-up work piece and purge gas; and,
C. Weld test piece according to specifications.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on Gas Tungsten Arc Welding
Transparencies will be prepared to emphasize each subject
Hobart Institute Video Material
Student worksheets and alloy charts
Personal protective equipment
GTAW equipment
Power supply
Control unit with shielding gas equipment and GTAW air cooled or water cooled torch
Examples of tungsten electrodes
Examples of torch gas nozzles in various sizes and styles
Various types of filler metal rods and wires
Shielding gas regulator, flow meters and accessory equipment
Selected metals for welding exercises
Welding shop tools
MASTER Handout No. 1 (WLD-O10-HO1)
MASTER Handout No. 2 (WLD-O10-HO2)

1993

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources; Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

Recommended Practices for Gas Tungsten Arc Welding, AWS Welding Handbook, Volume 1, Latest Edition

Welding Technology, Chapter 4, Welding Metallurgy, ANSI/AWS A5/18, American Welding Society, Miami, FL, Latest Edition

Specification for Carbon Steel Filler Metals for Gas Shielded Arc Welding, ANSI/AWS A5.10, American Welding Society, Miami, FL, Latest Edition

Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, ANSI/AWS A5.9, American Welding Society, Miami, FL, Latest Edition

Specification for Bare Stainless Steel Electrodes and Rods, ANSI/AWS A5.12, American Welding Society, Miami, FL, Latest Edition

Specification for Tungsten and Tungsten Alloy Electrodes for Arc Welding and Cutting, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the versatility of GTAW applications
- A discussion on methods leading to an increase of skill and knowledge in aluminum pipe welding applications

PRESENTATION OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Select electrode or filler metal, as appropriate
D. Identify GTAW equipment and inspect for safe operations
E. Identify GTAW welding variables and their effects on weld quality with aluminum pipe
F. Use GTAW to weld aluminum in the 6G position on pipe

Student Activities:

A. Set up GTAW equipment
B. Perform welding process prescribed in the 6G position on pipe
C. Perform in process weld inspection
D. Perform in process rework (if required)
E. Perform other exercises in student handbook, as recommended by instructor

PRACTICAL APPLICATION:

This module will assist the student in GTAW processes for aluminum pipe welding. To reduce the number of weld performance qualifications that may be required, qualification under certain conditions also qualifies for other conditions.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The purpose of this module is to prepare the student to use GTAW in welding aluminum pipe. Performance qualification tests are necessary to verify professional level quality by welders.

Qualification in the 6G (pipe axis inclined, fixed) position qualifies for all position fillet welding of plate and pipe and all position groove welding of plate and pipe, except for T-, Y-, and K- connections

The qualification tests described are specially devised to determine the ability of a welder, welding operator, or tack welder to produce sound welds in accordance with the requirements for the Welding Procedure Specification

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-P1) dealing with identifying and describing the function of Plasma Arc Cutting (PAC) equipment.

WLD-O10-HO1
Pass a Performance Qualification Test Using GTAW On Aluminum in the 6G Position on Pipe
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Set-up welding area and equipment;
B. Set-up work piece and purge gas; and,
C. Weld test piece according to specifications.

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Select electrode or filler metal, as appropriate
D. Identify GTAW equipment and inspect for safe operations
E. Identify GTAW welding variables and their effects on weld quality with aluminum pipe
F. Use GTAW to weld aluminum in the 6G position on pipe

Student Activities:

A. Set up GTAW equipment
B. Perform welding process prescribed in the 6G position on pipe
C. Perform in process weld inspection
D. Perform in process rework (if required)
E. Perform other exercises in student handbook, as recommended by instructor

WLD-O10-HO2
Pass a Performance Qualification Test Using GTAW On Aluminum in the 6G Position on Pipe
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
   - a. List advantages and disadvantages of GTAW
   - b. List five applications where GTAW or PAW are better suited
   - c. List give applications which are more suited to SMAW than GTAW
   - d. Compare and contrast GTAW and plasma arc welding (PAC)
   - e. List by name the parts of a GTAW torch
   - f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
   - g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 2F position
   - f. Weld a .050" fillet weld using .045" ER308-L
   - g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"
   - e. Fit up and tack a T joint and place in the 3F vertical position
   - f. Weld a .050" fillet weld using .045" ER308-L
   - g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
   - a. Conduct safety inspection of the area and equipment
   - b. Weld on 304 stainless steel
   - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   - d. Cut stainless steel to .050" X 2" X 10"

    e. Fit up and tack a T joint and place in the 4F overhead position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
9. Weld Pipe Open Root Passes All Positions Using GTAW
    a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
    b. Prepare tungsten for given procedure
    c. Set up GTAW torch for given procedure
    d. Set current for procedure
    e. Adjust shielding gas flow rate
    f. Weld root using free hand technique and using the walking the cup method
    g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    a. Use non-low hydrogen electrodes
    b. Strike arc and hold long arc length 1" away from last weld crater
    c. Back-up to previous weld crater holding long arc length
    d. Pre-heat crater with long arc
    e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    a. Use low hydrogen electrodes
    b. Strike arc 1" from crater
    c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    a. List the names and draw side views of the five basic joint configurations
    b. List the names and draw side views of the variations of grooves
    c. List the names and draw side views of the T-Joint variations
    d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    b. Clean bevel face with grinder as required
    c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

- a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
- b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
- c. List the polarity that air carbon arc is run on
- d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
- e. Connect air carbon torch arc and compressed air hose to welding machine
- f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    - a. Locate root of weld
    - b. Demonstrate control of depth of cut
    - c. Demonstrate control of width of cut
    - d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    - e. Make gouges of uniform depth
    - f. Observe discontinuities as gouging proceeds
    - g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    - a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    - b. Measure to make sure excavation is at proper location and depth
    - c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    - d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    - a. Check area for safety
    - b. Set SMAW equipment current and polarity for 1/8" E7018
    - c. Attach work lead
    - d. Preheat and maintain interpass temperature as required
    - e. Weld first pass paying special attention to low hydrogen techniques
    - f. Grind the weld start and stop to remove cold lap and lack of fusion
    - g. Weld the second pass starting from opposite end
    - h. Repeat starts and stops until weld is completed
    - i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    - a. Check work area for safety
    - b. Position steel in a T joint and tack at ends
    - c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    - d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    - e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDu PM0
072306

2003

2004

Duty P

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on lilife of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES

MASTER Technical Module No. WLD-P01

SUBJECT: **WELDING TECHNICIAN** **TIME: 5 HOURS**

- **DUTY:** **PLASMA ARC CUTTING AND WELDING**
- **TASK:** Identify and Describe the Function of Plasma Arc Cutting (PAC) Equipment

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand definitions and description of equipment;

B. Understand the principles of operation; and,

C. Identify equipment and apparatus requirements.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written tests on plasma arc cutting
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Plasma Arc Cutting and Welding Equipment
Welding shop tools
Power supply – control unit
Torch with torch cable
Ground clamp and lead assembly
Plasma, shielding and cooling gases and gas control components
MASTER Handout (WLD-P1-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Plasma Arc Cutting, ANSI/AWS C5.2-83 (an American National Standard), ISBN 0-87171-219-9, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Plasma Arc Welding, American Welding Society, Miami, FL, ISBN 0-87171-107-9, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses.

INTRODUCTION:

The Course Introduction will Include:

- A description of applications for plasma arc cutting and welding

---

PRESENTATION OUTLINE:

Instructor Topics:

A. PAC power sources
B. The principles involved in PAC equipment operation
C. Process conditions and gas selection
D. Typical PAC conditions for carbon steel and aluminum alloys
E. Identify polarity requirements using PAC on various metals
F. Demonstrate PAC in the flat, horizontal, vertical and overhead positions
G. Identify welding variables and their effects on weld quality

Student Activities:

A. Perform cutting of carbon steel and aluminum in four positions
B. Use oscillating and non-oscillating welding technique

PRACTICAL APPLICATION:

The purpose of this program is to assist the student in the use of plasma arc cutting equipment

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

Plasma-Arc Cutting (PAC) uses a jet of plasma to pierce, cut, and gouge metal. The plasma-arc cutting process requires an electrical power supply and a cutting gas. The plasma is created by superheating gas in an electric arc. Depending on the current flow, the temperature of the plasma may reach temperatures of 30,000 degrees Fahrenheit. The contact with metal of the jet plasma transfer tremendous heat, melting the metal instantly. The molten metal is blasted away by the jet blasts forming a hole, groove, or gouge. In most cases, the processes are faster and more efficient than any other cutting methods. The advantages of Plasma Arc Cutting are: (a) cuts both ferrous and nonferrous metals, (b) minimal slag, (c) high cutting speed, (d) very little or no distortion, and (e) very thin heat-affected zone.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-P2) dealing with identifying and describing the function of Plasma Arc Welding (PAW) equipment.

WLD-P1-HO
Identify and Describe the Function of Plasma Arc Cutting (PAC) Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Understand definitions and description of equipment;
B. Understand the principles of operation; and,
C. Identify equipment and apparatus requirements.

MODULE OUTLINE:

Instructor Topics:
A. PAC power sources
B. The principles involved in PAC equipment operation
C. Process conditions and gas selection
D. Typical PAC conditions for carbon steel and aluminum alloys
E. Identify polarity requirements using PAC on various metals
F. Demonstrate PAC in the flat, horizontal, vertical and overhead positions
G. Identify welding variables and their effects on weld quality

Student Activities:
A. Perform cutting of carbon steel and aluminum in four positions
B. Use oscillating and non-oscillating welding technique

WELDER SERIES

MASTER Technical Module No. WLD-P02

SUBJECT: **WELDING TECHNICIAN** **TIME: 6 HOURS**

- **DUTY:** **PLASMA ARC CUTTING AND WELDING**
- **TASK:** Identify and Describe the Function of Plasma Arc Welding (PAW) Equipment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand definitions and description of Plasma Arc Welding equipment;
B. Understand the principles of operation;
C. Identify equipment and apparatus requirements; and,
D. Understand safety factors with the operation and shut-down procedures.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on plasma arc welding
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Plasma Arc Cutting and Welding Equipment
Welding shop tools
Power supply – control unit
Torch with torch cable
Ground clamp and lead assembly
Plasma, shielding and cooling gases and gas control components
MASTER Handout (WLD-P2-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Plasma Arc Cutting, ANSI/AWS C5.2-83 (an American National Standard), ISBN 0-87171-219-9, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Plasma Arc Welding, American Welding Society, Miami, FL, ISBN 0-87171-107-9, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following technical module:

WLD-P01 "Identify and Describe the Function of Plasma Arc Cutting (PAC) Equipment"

INTRODUCTION:

The Course Introduction will Include:

- An overview of the applications of plasma arc welding

PRESENTATION OUTLINE:

Instructor Topics:

A. Principles involved in the operating of PAW equipment
B. Joint design concepts for PAW
C. Preparation of welding surfaces
D. Prepare butt joints, and tee joints, for welding
E. Demonstrate PAW in positions that are permitted for safe operations
F. Identify polarity requirements using PAW on various metals
G. Identify welding variables and their effects on weld quality

Student Activities:

A. Preheat weld surface
B. Perform welds in positions assigned and supervised by instructor
C. Make adjustments to improve weld quality

PRACTICAL APPLICATION

The purpose of this module is to assist the student in the use of plasma arc welding equipment to improve skill levels in order to pass any welding test or certification test for employment as a welding technician, or to provide supplemental training for persons previously or currently employed in these occupations.

The student will gain an understanding of more exotic forms of welding of higher melting point metals. PAW can weld stainless steel as well as titanium.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

A plasma arc torch makes possible the melting of the most refractory materials and the welding of the higher melting point metals. The PAW water-cooled torch has two channels for gas - one for plasma gas and one for shielding gas. With the plasma torch, temperatures as high as 30,000 degrees F can be developed and even higher temperatures are possible. Advantages are greater energy concentration, improved arc stability, higher welding speeds, and lower width to depth ratio for a given penetration.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-P3) dealing with understanding the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes.

WLD-P2-HO
Identify and Describe the Function of Plasma Arc Welding (PAW) Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand definitions and description of Plasma Arc Welding equipment;
B. Understand the principles of operation;
C. Identify equipment and apparatus requirements; and,
D. Understand safety factors with the operation and shut-down procedures.

MODULE OUTLINE:

Instructor Topics:

A. Principles involved in the operating of PAW equipment
B. Joint design concepts for PAW
C. Preparation of welding surfaces
D. Prepare butt joints, and tee joints, for welding
E. Demonstrate PAW in positions that are permitted for safe operations
F. Identify polarity requirements using PAW on various metals
G. Identify welding variables and their effects on weld quality

Student Activities:

A. Preheat weld surface
B. Perform welds in positions assigned and supervised by instructor
C. Make adjustments to improve weld quality

WELDER SERIES

MASTER Technical Module No. WLD-P03

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **PLASMA ARC CUTTING AND WELDING**
- **TASK:** Understand the Safety Factors in Plasma Arc Cutting and Plasma Arc Welding Processes

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Select and use No. 6 filter lens, with side shields, as recommended when welding with transferred arc currents up to 5A; and,

B. When welding with transferred arc currents between 5 and 15A, use a full face light green plastic shield as recommended in addition to eye protection with No. 6 filter.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on plasma arc safety and procedures
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Plasma Arc Cutting and Welding Equipment
Welding shop tools
Power supply – control unit
Torch with torch cable
Ground clamp and lead assembly
Plasma, shielding and cooling gases and gas control components
MASTER Handout (WLD-P3-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Recommended Practices for Plasma Arc Cutting, ANSI/AWS C5.2-83R, An American National Standard, American Welding Society, ISBN: 0-87171-219-9, Latest Edition
Recommended Practices for Plasma Arc Welding, American Welding Society, ISBN: 0-87171-107-9, Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Plasma Arc Cutting, ANSI/AWS C5.2-83 (an American National Standard), ISBN 0-87171-219-9, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Plasma Arc Welding, American Welding Society, Miami, FL, ISBN 0-87171-107-9, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- Background facts and general principles requiring only the highest levels of safety when using PAC and PAW processes

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Principles involved in the operating of PAC & PAW equipment
B. Joint design and welding terms
C. Proper application of welding skills for PAC and PAW processes
D. Adequate preparation of welding surfaces
E. Increase knowledge of current industry standards and techniques

F. Demonstrate PAC & PAW in the positions that can be safely used with existing equipment
G. Identify polarity requirements using PAC & PAW on various metals
H. Demonstrate preheat and how to maintain desired temperature
I. Identify welding variables and their effects on weld quality
J. Match PAC & PAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in positions assigned and supervised by instructor
C. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The purpose of this module is to assist the student in the use of plasma arc protective equipment and explain safety factors in PAC and PAW processes.

In this module, the student will gain a greater knowledge of safety requirements and gain confidence with PAC and PAW applications.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

Controls on larger units typically include a power on/off switch, output current control and a meter, gas flow controls and gauges, gas selector controls, local/remote switch and open circuit volt meter. Larger units often operate with several types of gases.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-P4) dealing with setting up Plasma Arc Cutting equipment.

WLD-P3-HO
Understand the Safety Factors in Plasma Arc Cutting And Plasma Arc Welding Processes
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Select and use No. 6 filter lens, with side shields, as recommended when welding with transferred arc currents up to 5A; and,

B. When welding with transferred arc currents between 5 and 15A, use a full face light green plastic shield as recommended in addition to eye protection with No. 6 filter.

MODULE OUTLINE:

Instructor Topics:

A. Principles involved in the operating of PAC & PAW equipment
B. Joint design and welding terms
C. Proper application of welding skills for PAC and PAW processes
D. Adequate preparation of welding surfaces
E. Increase knowledge of current industry standards and techniques
F. Demonstrate PAC & PAW in the positions that can be safely used with existing equipment
G. Identify polarity requirements using PAC & PAW on various metals
H. Demonstrate preheat and how to maintain desired temperature
I. Identify welding variables and their effects on weld quality
J. Match PAC & PAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in positions assigned and supervised by instructor
C. Make adjustments to improve weld quality

WLD-P4

WELDER SERIES

MASTER Technical Module No. WLD-P04

SUBJECT: **WELDING TECHNICIAN** **TIME: 6 HOURS**

- **DUTY:** **PLASMA ARC CUTTING AND WELDING**
- **TASK:** Set-Up Plasma Arc Cutting (PAC) Equipment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify power hook-up requirements;
B. Identify air pressure requirements for Plasma Arc Cutting (PAC) equipment;
C. Perform set-up Plasma Arc Cutting (PAC) equipment in a safe manner; and,
D. Troubleshoot Plasma Arc Cutting (PAC) equipment.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Plasma Arc Cutting and Welding Equipment
Welding shop tools
Power supply – control unit
Torch with torch cable
Ground clamp and lead assembly
Plasma, shielding and cooling gases and gas control components
MASTER Handout (WLD-P4-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Plasma Arc Cutting, ANSI/AWS C5.2-83 (an American National Standard), ISBN 0-87171-219-9, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Plasma Arc Welding, American Welding Society, Miami, FL, ISBN 0-87171-107-9, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of special applications for PAC and PAW processes

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of PAC equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Increase skill level to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Demonstrate PAC in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using PAC on various metals
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match PAC electrodes to an appropriate base metal

Student Activities:

- A. Preheat weld surface
- B. Perform welds in positions assigned and supervised by instructor
- C. Use oscillating and non-oscillating welding technique
- D. Perform single pass and multi-pass welds
- E. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The purpose of this program is to assist the student in the use of PAC and PAW equipment to improve skill levels.

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

A start or idle arc is ignited between electrode and the nozzle. A small amount of gas is injected into the arc chamber where it is heated to a plasma and escapes through the torch nozzle as a fine jet. The control unit increases the amperage and gas flow to produce the longer cutting arc.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-P5) dealing with setting up Plasma Arc Welding equipment.

WLD-P4-HO
Set-Up Plasma Arc Cutting Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify power hook-up requirements;
B. Identify air pressure requirements for Plasma Arc Cutting (PAC) equipment;
C. Perform set-up Plasma Arc Cutting (PAC) equipment in a safe manner; and,
D. Troubleshoot Plasma Arc Cutting (PAC) equipment.

MODULE OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of PAC equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Increase skill level to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Demonstrate PAC in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using PAC on various metals
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match PAC electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in positions assigned and supervised by instructor
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WELDER SERIES

MASTER Technical Module No. WLD-P05

SUBJECT: **WELDING TECHNICIAN** **TIME: 5 HOURS**

- **DUTY:** **PLASMA ARC CUTTING AND WELDING**
- **TASK:** Set-Up Plasma Arc Welding Equipment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform set-up of Plasma Arc Welding (PAW) equipment in a safe manner;
B. Troubleshoot Plasma Arc Welding (PAW) equipment;
C. Understand terms and definitions of Plasma Arc Welding (PAW) processes;
D. Understand principles of operation of manual Plasma Arc Welding (PAW) [per AWS Recommended Policies for Plasma Arc Welding C5.1-73;3.2]; and,
E. Understand equipment and apparatus requirements (per AWS C5.1-73;4.1).

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Plasma Arc Cutting and Welding Equipment
Welding shop tools
Power supply – control unit
Torch with torch cable
Ground clamp and lead assembly
Plasma, shielding and cooling gases and gas control components
MASTER Handout (WLD-P5-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition

Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition

The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources, Pierre, Edward R.; Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

Recommended Practices for Plasma Arc Cutting, ANSI/AWS C5.2-83 (an American National Standard), ISBN 0-87171-219-9, American Welding Society, Miami, FL, Latest Edition

Recommended Practices for Plasma Arc Welding, American Welding Society, Miami, FL, ISBN 0-87171-107-9, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of PAW applications
- A class demonstration of effective plasma arc welding techniques

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of PAW equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Increase skill level to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Demonstrate PAW in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using PAW on various metals

K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match PAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in positions approved and supervised by instructor
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Welds will be evaluated by instructor and student.

SUMMARY:

Filler metals for PAW, when needed, are generally the same as those used in GTAW.

The metal in the filler rod should match the base metal as closely as possible.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-P6) dealing with performing Plasma Arc Cutting and Plasma Arc Welding on various materials.

WLD-P5-HO
Set-Up Plasma Arc Welding Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform set-up of Plasma Arc Welding (PAW) equipment in a safe manner;
B. Troubleshoot Plasma Arc Welding (PAW) equipment;
C. Understand terms and definitions of Plasma Arc Welding (PAW) processes;
D. Understand principles of operation of manual Plasma Arc Welding (PAW) [per AWS Recommended Policies for Plasma Arc Welding C5.1-73;3.2]; and,
E. Understand equipment and apparatus requirements (per AWS C5.1-73;4.1).

MODULE OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of PAW equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Increase skill level to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Demonstrate PAW in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using PAW on various metals
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match PAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in positions approved and supervised by instructor
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WELDER SERIES

MASTER Technical Module No. WLD-P06

SUBJECT: **WELDING TECHNICIAN** **TIME: 6 HOURS**

- **DUTY:** **PLASMA ARC CUTTING AND WELDING**
- **TASK:** Perform Plasma Arc Cutting and Plasma Arc Welding on Various Materials

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Gouge ferrous and non-ferrous metals according to industry standards;
B. Cut various angles on ferrous and non-ferrous metals; and,
C. Weld ferrous and non-ferrous metals according to industry standards using Plasma Arc Welding (PAW) equipment.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Plasma Arc Cutting and Welding Equipment
Welding shop tools
Power supply – control unit
Torch with torch cable
Ground clamp and lead assembly
Plasma, shielding and cooling gases and gas control components
MASTER Handout (WLD-P6-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Plasma Arc Cutting, ANSI/AWS C5.2-83 (an American National Standard), ISBN 0-87171-219-9, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Plasma Arc Welding, American Welding Society, Miami, FL, ISBN 0-87171-107-9, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of applications with industries to include aerospace and NASA
- A class demonstration of effective plasma arc cutting and welding techniques
- A discussion on methods leading to increased skills

PRESENTATION OUTLINE:

Instructor Topics:

A. Principles involved in the operating of PAC & PAW equipment
B. Knowledge of joint design and welding terms
C. Interpret drawings and blueprints for PAC and PAW applications
D. Proper application of welding skills
E. Preparation of welding surfaces
F. Description of skill levels needed to pass certification tests offered by an employer
G. Prepare joints for welding
H. Demonstrate PAC & PAW in the flat, horizontal, vertical and overhead positions
I. Identify polarity requirements using PAC & PAW on various metals
J. Demonstrate preheat and how to maintain desired temperature
K. Identify welding variables and their effects on weld quality

L. Identify the AISI steel classification system
M. Match PAC & PAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions, or as approved by instructor for safe conditions
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

PRACTICAL APPLICATION:

The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Cutting and welding will be compared to AWS and industry standards.

SUMMARY:

In PAW, the arc from a tungsten electrode heats and ionizes a gas. A high frequency generator starts the plasma arc. In practice, welding currents are at least 1 Amp and seldom exceed 400 Amps.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-P7) dealing with performing shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment.

WLD-P6-HO
Perform Plasma Arc Cutting and Plasma Arc Welding on Various Materials
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Gouge ferrous and non-ferrous metals according to industry standards;
B. Cut various angles on ferrous and non-ferrous metals; and,
C. Weld ferrous and non-ferrous metals according to industry standards using Plasma Arc Welding (PAW) equipment.

MODULE OUTLINE:

Instructor Topics:

A. Principles involved in the operating of PAC & PAW equipment
B. Knowledge of joint design and welding terms
C. Interpret drawings and blueprints for PAC and PAW applications
D. Proper application of welding skills
E. Preparation of welding surfaces
F. Description of skill levels needed to pass certification tests offered by an employer
G. Prepare joints for welding
H. Demonstrate PAC & PAW in the flat, horizontal, vertical and overhead positions
I. Identify polarity requirements using PAC & PAW on various metals
J. Demonstrate preheat and how to maintain desired temperature
K. Identify welding variables and their effects on weld quality
L. Identify the AISI steel classification system
M. Match PAC & PAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions, or as approved by instructor for safe conditions
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WELDER SERIES

MASTER Technical Module No. WLD-P07

SUBJECT: WELDING TECHNICIAN TIME: 3 HOURS

- **DUTY:** **PLASMA ARC CUTTING AND WELDING**
- **TASK:** Perform Shut-Down Procedures on Plasma Arc Cutting and Plasma Arc Welding Equipment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand shut-down procedures on Plasma Arc Cutting (PAC) and Plasma Arc Welding (PAW) equipment;

B. Perform air and gas shut-down procedures; and,

C. Perform clean-up of work area.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
Personal protective equipment
Plasma Arc Cutting and Welding Equipment
Welding shop tools
Power supply – control unit
Torch with torch cable
Ground clamp and lead assembly
Plasma, shielding and cooling gases and gas control components
MASTER Handout (WLD-P7-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition

Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R.; Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Plasma Arc Cutting, ANSI/AWS C5.2-83 (an American National Standard), ISBN 0-87171-219-9, American Welding Society, Miami, FL, Latest Edition
Recommended Practices for Plasma Arc Welding, American Welding Society, Miami, FL, ISBN 0-87171-107-9, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- The need for extreme care to be exercised in shut down procedures for PAC and PAW processes
- A class demonstration of effective shut down and clean up from PAC/PAW techniques
- A discussion of hazards that may be encountered in this phase of production welding

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Principles involved in the operating of PAC & PAW equipment
B. Gouging and Cutting of ferrous and non-ferrous metals
C. Joint preparation and cleaning of surfaces for welding
D. Shut down sequence for PAC and PAW processes

Student Activities:

A. Perform shut down operation for PAC and PAW
B. Inspect equipment
C. Clean weld surface
D. Clean workplace and equipment

PRACTICAL APPLICATION:

The purpose of this program is to assist the student by emphasizing safe shut down procedures for PAC and PAW processes. The student will gain knowledge and experience with as much practice as possible.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

Shut down operations are always very significant steps for the welder. Welder equipment must be inspected, maintained, cleaned and properly secured.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-Q1) dealing with checking weld size.

WLD-P7-HO
Perform Shut Down Procedures on Plasma Arc Cutting And Plasma Arc Welding Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand shut-down procedures on Plasma Arc Cutting (PAC) and Plasma Arc Welding (PAW) equipment;
B. Perform air and gas shut-down procedures; and,
C. Perform clean-up of work area.

MODULE OUTLINE:

Instructor Topics:

A. Principles involved in the operating of PAC & PAW equipment
B. Gouging and cutting of ferrous and non-ferrous metals
B. Joint preparation and cleaning of surfaces for welding
C. Shut down sequence for PAC and PAW processes

Student Activities:

A. Perform shut down operation for PAC and PAW
B. Inspect equipment
C. Clean weld surface
D. Clean workplace and equipment

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

	Duties	Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethic, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Read/convert Metric-English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 Perform GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDr.PMS
072396

2035

2036

Duty Q

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		← Tasks →												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES

MASTER Technical Module No. WLD-Q1

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **IN-PROCESS WELD INSPECTION**
- **TASK:** Check Weld Size

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify weld specification;
B. Identify weld gages and their use;
C. Identify the symbol for weld size (specification); and,
D. Identify common causes of discontinuities related to shape, size and contour.

INSTRUCTIONAL MATERIALS:

Student Workbook
Written test on welding discontinuities and defects
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
MASTER Handout (WLD-Q1-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding Inspection, American Welding Society, Miami, Florida, Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition

Welding Processes and Power Sources, Pierre, Edward R.; Burgess Publishing, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- The importance of weld quality to customers
- A class demonstration of effective inspection techniques
- A discussion on methods leading to increase of skill and knowledge in order to become a competent weld inspector

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Welding size variation and specification
B. Illustrate visual inspection
C. Identify welding variables relevant to the prevention of specific weld imperfections
D. How to gage weld size
E. How to follow a welding procedure specification (WPS)
F. When to apply multi-pass welds
G. When to apply weaving technique
H. How to determine speed of travel

Student Activities:

A. Increased knowledge and skill of weld inspection by demonstration
B. Determine weld quality for acceptability to a code or standard
C. Determine defects in weld quality
D. Perform dye penetration test

PRACTICAL APPLICATION:

The purpose of this module is to assist the student in the use of in process weld inspection techniques. The student will apply skills learned in this module to determine weld defects.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class. Students will use measurement tools to determine weld size.

SUMMARY:

The module focused on knowledge and application of quality standards applied through selected weld processes and individual weld techniques during welding operations.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-Q2) dealing with performing visual inspection.

WLD-Q1-HO
Check Weld Size
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify weld specification;
B. Identify weld gages and their use;
C. Identify the symbol for weld size (specification); and,
D. Identify common causes of discontinuities related to shape, size and contour.

MODULE OUTLINE:

Instructor Topics:

A. Welding size variation and specification
B. Illustrate visual inspection
C. Identify welding variables relevant to the prevention of specific weld imperfections
D. How to gage weld size
E. How to follow a welding procedure specification (WPS)
F. When to apply multi-pass welds
G. When to apply weaving technique
H. How to determine speed of travel

Student Activities:

A. Increased knowledge and skill of weld inspection by demonstration
B. Determine weld quality for acceptability to a code or standard
C. Determine defects in weld quality
D. Perform dye penetration test

WELDER SERIES

MASTER Technical Module No. WLD-Q2

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **IN-PROCESS WELD INSPECTION**
- **TASK:** Perform Visual Inspection

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify and define weld discontinuities and defects;
B. Identify the Welding Inspectors responsibilities relating to discontinue and defects;
C. Identify the common causes of discontinuities related to shape, size and contour;
D. Identify the common causes of discontinuities related to internal inconsistencies and weld metal irregularities; and,
E. Identify the common causes of discontinuities related to weld and base metal properties.

INSTRUCTIONAL MATERIALS:

Student Workbook
One written test on welding discontinuities and defects
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
MASTER Handout (WLD-Q2-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition

Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R.; Burgess Publishing, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of quality inspection techniques
- A class demonstration of effective inspection techniques
- A discussion on methods leading to an increase of skill and knowledge in order to determine defects and discontinuities

---

PRESENTATION OUTLINE:

Instructor Topics:

A. Welding size variation and specification
B. Visual inspection methods
C. Welding variables that can be controlled to prevent specific weld imperfections
D. How to gage weld size
E. Include nondestructive and destructive testing techniques
F. How to follow a Welding Procedure Specification (WPS)
G. Selection of samples for tests
H. Proof and leak tests
I. How to inspect for welding defects: cracks, cavities, solid inclusions, incomplete fusion, defects in weld shape and contour, arc strikes, and excessive spatter
J. Non-destructive evaluations: dye-penetrant, florescent penetrant, magnetic particle, ultrasonic, and radiographic
K. Destructive evaluations: mechanical (tensile and sheer), metallurgical (specimen for photomicrographs of metallic structure, defects, etc.)

Student Activities:

- A. Determine weld quality for acceptability to a code or standard
- B. Determine defects in weld quality
- C. Perform destructive and non-destructive testing

PRACTICAL APPLICATION:

The purpose of this module is to assist the student in the use of visual inspection to determine defects and discontinuities. The student will apply skills learned in lab to determine weld defects and perform testing.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The discussion will focus on quality standards , weld inspection, and weld testing methods.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-R1) dealing with removing weld defect and prepare for re-weld.

WLD-Q2-HO
Perform Visual Inspection
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify and define weld discontinuities and defects;
B. Identify the Welding Inspectors responsibilities relating to discontinue and defects;
C. Identify the common causes of discontinuities related to shape, size and contour;
D. Identify the common causes of discontinuities related to internal inconsistencies and weld metal irregularities; and,
E. Identify the common causes of discontinuities related to weld and base metal properties.

MODULE OUTLINE:

Instructor Topics:

A. Welding size variation and specification
B. Visual inspection methods
C. Welding variables that can be controlled to prevent specific weld imperfections
D. How to gage weld size
E. Include nondestructive and destructive testing techniques
F. How to follow a Welding Procedure Specification (WPS)
G. Selection of samples for tests
H. Proof and leak tests
I. How to inspect for welding defects: cracks, cavities, solid inclusions, incomplete fusion, defects in weld shape and contour, arc strikes, and excessive spatter
J. Non-destructive evaluations: dye-penetrant, florescent penetrant, magnetic particle, ultrasonic, and radiographic
K. Destructive evaluations: mechanical (tensile and sheer), metallurgical (specimen for photomicrographs of metallic structure, defects, etc.)

Student Activities:

A. Determine weld quality for acceptability to a code or standard
B. Determine defects in weld quality
C. Perform destructive and non-destructive testing

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDs.PM0
072996

2047

Duty R

2048

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 60 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

2049

2050

WELDER SERIES

MASTER Technical Module No. WLD-R01

SUBJECT: WELDING TECHNICIAN TIME: 6 HOURS

- **DUTY: IN-PROCESS REWORK**
- **TASK:** Remove Weld Defect and Prepare for Re-weld

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify weld defects;
B. Understand surface preparation; and,
C. Perform remodel of weld discontinuities.

INSTRUCTIONAL MATERIALS:

Student Workbook
One written tests on weld re-work
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
MASTER Handout (WLD-R1-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R., Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of weld defects
- A class demonstration of effective defect removal or re-weld techniques
- A discussion on methods leading to prevention of defects

PRESENTATION OUTLINE:

Instructional Topic:

A. Describe the most common welding problems for various welding processes
B. Perform visual inspection
C. Prepare geometry for reweld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size

Student Activities:

A. Remove weld defect
B. Prepare weld surface for re-weld
C. Check weld size using gages
D. Re-weld workpiece

PRACTICAL APPLICATION:

The purpose of this module is to assist the student in the use of facilities and equipment to remove weld defects and prepare for re-weld, if applicable. The student will make use of air tools, grinders, files and welding equipment to remove weld defects and gain knowledge on how to identify weld defects to improve quality.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The student should master defect removal, as well as prevention of defects.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-R2) dealing with verifying defect removal.

WLD-R1-HO
Remove Weld Defect and Prepare for Re-Weld
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Identify weld defects;
B. Understand surface preparation; and,
C. Perform remodel of weld discontinuities.

MODULE OUTLINE:

Instructional Topic:
A. Describe the most common welding problems for various welding processes
B. Perform visual inspection
C. Prepare geometry for reweld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size

Student Activities:
A. Remove weld defect
B. Prepare weld surface for re-weld
C. Check weld size using gages
D. Re-weld workpiece

WELDER SERIES

MASTER Technical Module No. WLD-R02

SUBJECT: WELDING TECHNICIAN TIME: 6 HOURS

- **DUTY:** **IN-PROCESS REWORK**
- **TASK:** Verify Defect Removal

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Identify weld defects; and,
B. Remove weld defects.

INSTRUCTIONAL MATERIALS:

Student Workbook
One written test on weld re-work
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
MASTER Handout (WLD-R1-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R., Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the defects and process of removal
- A discussion on methods leading to prevention of defects

PRESENTATION OUTLINE:

Instructional Topic:

A. Describe the most common welding problems for various welding processes
B. Perform visual inspection
C. Prepare geometry for re-weld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size

Student Activities:

A. Remove weld defect
B. Prepare weld surface for reweld
C. Check weld size using gages
D. Re-weld workpiece

PRACTICAL APPLICATION:

The purpose of this module is to assist the student in verifying defect removal and the performance of repairs. The student will make use of air tools, grinders, files and oxyacetylene equipment to remove weld defects and gain knowledge on how to identify weld defects to improve quality.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The student must be aware of common problems with welding equipment, as well as substandard welding techniques, and how to rectify problem.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-R3) dealing with pre-heating weld (if required).

WLD-R2-HO
Verify Defect Removal
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify weld defects; and,
B. Remove weld defects.

MODULE OUTLINE:

Instructional Topic:

A. Describe the most common welding problems for various welding processes
B. Perform visual inspection
C. Prepare geometry for re-weld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size

Student Activities:

A. Remove weld defect
B. Prepare weld surface for reweld
C. Check weld size using gages
D. Re-weld workpiece

WELDER SERIES

MASTER Technical Module No. WLD-R03

SUBJECT: WELDING TECHNICIAN TIME: 5 HOURS

- **DUTY: IN-PROCESS REWORK**
- **TASK:** Pre-Heat Weld (If Required)

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand pre-heating procedures and requirements; and,

B. Understand post-heating requirement procedures.

INSTRUCTIONAL MATERIALS:

Student Workbook
One written test on weld re-work
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
MASTER Handout (WLD-R3-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R., Burgess Publishing, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of a fast growing technical field with many opportunities and excellent pay

PRESENTATION OUTLINE:

Instructional Topic:

A. Rationale for pre-heating and post-heating
B. Perform visual inspection
C. Prepare geometry for re-weld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size
K. Post-heat, if specified

Student Activities:

A. Practice pre-heat
B. Practice post-heat

PRACTICAL APPLICATION:

The purpose of this module is to assist the student in the performance of pre-heating and post-heating during rework and weld repairs.

The student will understand the reasons for pre-heating and post-heating.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The student must be aware of common problems that are associated with metal preparation.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-R4) dealing with performing re-weld.

WLD-R3-HO
Pre-Heat Weld (If Required)
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand pre-heating procedures and requirements; and,
B. Understand post-heating requirement procedures.

MODULE OUTLINE:

Instructional Topic:

A. Rationale for pre-heating and post-heating
B. Perform visual inspection
C. Prepare geometry for re-weld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size
K. Post-heat, if specified

Student Activities:

A. Practice pre-heat
B. Practice post-heat

WELDER SERIES

MASTER Technical Module No. WLD-R04

SUBJECT: WELDING TECHNICIAN TIME: 6 HOURS

- **DUTY: IN-PROCESS REWORK**
- **TASK:** Perform Re-weld

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform pre-heat;
B. Understand weld requirements; and,
C. Perform reweld as required.

INSTRUCTIONAL MATERIALS:

Student Workbook
One written test on weld re-work
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
MASTER Handout (WLD-R4-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey: Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R., Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the purpose of rework
- A discussion on methods leading to preventing rework

PRESENTATION OUTLINE:

Instructional Topic:

A. Describe the most common welding problems for various welding processes
B. Perform visual inspection
C. Prepare geometry for re-weld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size

Student Activities:

A. Remove weld defect
B. Prepare weld surface for re-weld
C. Check weld size using gages
D. Re-weld workpiece

PRACTICAL APPLICATION:

The purpose of this module is to assist the student in the use of welding facilities and equipment for rework. The student will make use of air tools, grinders, files and welding equipment to remove weld defects and reweld as appropriate.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class.

SUMMARY:

The student should be aware of common problems with rework and understand the proper methods of re-welding the product.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-R5) dealing with repeating in-process inspection.

WLD-R4-HO
Perform Re-Weld
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform pre-heat;
B. Understand weld requirements; and,
C. Perform reweld as required.

MODULE OUTLINE:

Instructional Topic:

A. Describe the most common welding problems for various welding processes
B. Perform visual inspection
C. Prepare geometry for re-weld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size

Student Activities:

A. Remove weld defect
B. Prepare weld surface for re-weld
C. Check weld size using gages
D. Re-weld workpiece

WELDER SERIES

MASTER Technical Module No. WLD-R05

SUBJECT: WELDING TECHNICIAN TIME: 4 HOURS

- **DUTY:** **IN-PROCESS REWORK**
- **TASK:** Repeat In-Process Inspection

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform in-process rework;
B. Inspect weld after repair; and,
C. Understand weld requirements.

INSTRUCTIONAL MATERIALS:

Student Workbook
One written test on inspection techniques
Transparencies prepared to emphasize each subject
Hobart Institute Video Material
The classroom handouts will consist of student worksheets and alloy charts
MASTER Handout (WLD-R5-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Welding Technology Today, Principles and Practices, Stinchcomb, Craig. New Jersey Prentice Hall, Inc., (ISBN 0-13-924416-6), Latest Edition
Welder Handbook, W-100 E-1 Corp., Publication #51077, Latest Edition
Competency Standards, American Welding Society, Latest Edition
Tool and Manufacturing Engineers Handbook (Volumes 3 and 4), Society of Manufacturing Engineers, (ISBN 0-87263-176-1 and ISBN 0-87263-177-X), Latest Edition
The Procedure Handbook of Arc Welding, The Lincoln Electric Company, Cleveland, OH, Latest Edition
Welding Processes and Power Sources, Pierre, Edward R., Burgess Publishing, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The Course Introduction will Include:

- An overview of the welding inspection text by the American Welding Society
- A discussion on effective inspection methods leading to prevention of rework

---

PRESENTATION OUTLINE:

Instructional Topic:

A. Perform visual inspection
B. Testing of welds
C. Prepare geometry for re-weld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size

Student Activities:

A. Remove weld defect
B. Prepare weld surface for re-weld
C. Check weld size using gages
D. Re-weld workpiece

PRACTICAL APPLICATION:

The purpose of this module is to assist the student in the use of inspection methods recommended by the American Welding Society. The student will repeat the inspection process to insure good product and reinforce the need for “quality the first time”.

EVALUATION AND/OR VERIFICATION:

An examination will be given at the end of this section to determine the progress of the class and mastery of AWS inspection standards.

SUMMARY:

Quality is doing the job right the first time and verifying it according to standards.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-S1) dealing with returning unused consumables.

WLD-R5-HO
Repeat In-Process Inspection
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform in-process rework;
B. Inspect weld after repair; and,
C. Understand weld requirements.

MODULE OUTLINE:

Instructional Topic:

A. Perform visual inspection
B. Testing of welds
C. Prepare geometry for re-weld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size

Student Activities:

A. Remove weld defect
B. Prepare weld surface for re-weld
C. Check weld size using gages
D. Re-weld workpiece

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	[illegible] GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

2072

BEST COPY AVAILABLE

2071

Duty S

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES

MASTER Technical Module No. WLD-S01

SUBJECT: **WELDING TECHNICIAN** **TIME: 2 HOURS**

- **DUTY:** **HOUSEKEEPING ACTIVITIES**
- **TASK:** Return Unused Consumables

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Place unused materials in their assigned locations for future use; and,

B. Understand the rationale for tracking programmed materials for specific jobs.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-S1-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual, Latest Edition
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Students must complete all previous modules.

INTRODUCTION:

Welding employers expect welders to practice "supply economy" or placing unused materials in the assigned location where they can be used by others in production.

PRESENTATION OUTLINE:

Instructional Topics:

- A. Principles of economy in the use of materials
- B. Assigned locations materials located for specific jobs
- C. Assigned locations for consumables
- D. Tracking costs of misplaced or lost materials

Student Activities:

- A. Exercises assigned by instructor to recommend location for materials and consumables
- B. Estimating costs of misplaced or lost materials

PRACTICAL APPLICATION:

Students will be more aware of the potential loss of materials and the cost of production in time and dollars.

EVALUATION AND/OR VERIFICATION:

A quiz will be given at the end of the module to verify employee awareness of the problem.

SUMMARY:

Major quantities of welding materials are lost each year by industrial production and construction firms.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-S2) dealing with storing tools.

WLD-S1-HO
Return Unused Consumables
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Place unused materials in their assigned locations for future use; and,
B. Understand the rationale for tracking programmed materials for specific jobs.

MODULE OUTLINE:

Instructional Topics:

A. Principles of economy in the use of materials
B. Assigned locations materials located for specific jobs
C. Assigned locations for consumables
D. Tracking costs of misplaced or lost materials

Student Activities:

A. Exercises assigned by instructor to recommend location for materials and consumables
B. Estimating costs of misplaced or lost materials

WELDER SERIES

MASTER Technical Module No. WLD-S02

SUBJECT: **WELDING TECHNICIAN** **TIME: 5 HOURS**

- **DUTY:** **HOUSEKEEPING ACTIVITIES**
- **TASK:** Store Tools

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Place tools in their assigned location; and,

B. Maintain tools in a safe condition in an available status.

INSTRUCTIONAL MATERIALS:

- **MASTER** Handout (WLD-S2-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition

Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition

Specific Company Safety Policy and Procedures Manual, Latest Edition

OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

The availability of safe, well maintained tools is a major consideration for the professional welder. They should not be left in a "hot" condition or on aisles or corridors.

PRESENTATION OUTLINE:

Instructional Topics:

A. The significance of tools to the professional
B. How to maintain welders tools and equipment
C. How to secure welders tools and equipment
D. How to inspect the tools for operability

Student Activities:

A. Assigns locations and layout of tools
B. Practical exercise in mandatory tools

PRACTICAL APPLICATION:

Students will become aware of the criticality of tool condition and status.

EVALUATION AND/OR VERIFICATION:

A quiz will be used to verify student awareness and knowledge of the subject.

SUMMARY:

Many jobs have required rework or have been rejected, costing time and money, as a result of tool condition or non-availability.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-S3) dealing with securing welding equipment.

WLD-S2-HO
Store Tools
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Place tools in their assigned location; and,
B. Maintain tools in a safe condition in an available status.

MODULE OUTLINE:

Instructional Topics:

A. The significance of tools to the professional
B. How to maintain welders tools and equipment
C. How to secure welders tools and equipment
D. How to inspect the tools for operability

Student Activities:

A. Assigns locations and layout of tools
B. Practical exercise in mandatory tools

WELDER SERIES

MASTER Technical Module No. WLD-S03

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **HOUSEKEEPING ACTIVITIES**
- **TASK:** Secure Welding Equipment

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Shut down equipment; and,

B. Secure equipment in a safe, stable, and non-operational state.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-S3-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual, Latest Edition
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

Equipment shut down procedures and storage in assigned location are matters of great cost consideration due to potential safety hazards and possible liability cost.

PRESENTATION OUTLINE:

Instructional Topics:

A. Essential shut down operations (specifics are covered in other modules)
B. Equipment to be left in stable, non-hazardous state
C. Equipment to be located in safe location
D. Final inspection of equipment to preclude future loss and insure operability

Student Activities:

A. Recommended locations for all equipment
B. Inspect shop by OSHA Rules

PRACTICAL APPLICATION:

Students will be aware of potential safety and cost risks to themselves and their employers.

EVALUATION AND/OR VERIFICATION:

A quiz will be given to verify knowledge of shut down procedures and determine new responsibility/attitude to this process.

SUMMARY:

Losses from improper shut down have been very great to industry and construction enterprises.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-S4) dealing with securing welding gases.

WLD-S3-HO
Secure Welding Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Shut down equipment; and,
B. Secure equipment in a safe, stable, and non-operational state.

MODULE OUTLINE:

Instructional Topics:

A. Essential shut down operations (specifics are covered in other modules)
B. Equipment to be left in stable, non-hazardous state
C. Equipment to be located in safe location
D. Final inspection of equipment to preclude future loss and insure operability

Student Activities:

A. Recommended locations for all equipment
B. Inspect shop by OSHA Rules

WELDER SERIES

MASTER Technical Module No. WLD-S04

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **HOUSEKEEPING ACTIVITIES**
- **TASK:** Secure Welding Gases

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Secure welding gases in a safe condition; and,
B. Shut down gas operations in an approved manner.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-S4-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual, Latest Edition
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

Approved storage procedures for welding gases should be mandatory at all companies.

PRESENTATION OUTLINE:

Instructional Topics:

A. How to identify damage to compressed gas cylinders, valves, hoses, gages, and regulators.
B. Indications of leaks and corrosion
C. Contaminated valves
D. Flammable and non-flammable hazards of compressed gases used in welding process
E. Securing of lines and regulators
F. Proper storing of all gases and liquids

Student Activities:

A. Practice securing equipment
B. Practice storing or locating equipment in proper location

PRACTICAL APPLICATION:

Operation of shop will be performed in compliance with OSHA rules and regulations.

EVALUATION AND/OR VERIFICATION:

Examination to verify knowledge and understanding of these processes.

SUMMARY:

Proper shutdown and storage saves lives, equipment, and time. It also insures continued future production.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-S5) dealing with cleaning work area(s).

WLD-S4-HO
Secure Welding Gases
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Secure welding gases in a safe condition; and,

B. Shut down gas operations in an approved manner.

MODULE OUTLINE:

Instructional Topics:

A. How to identify damage to compressed gas cylinders, valves, hoses, gages, and regulators.

B. Indications of leaks and corrosion

C. Contaminated valves

D. Flammable and non-flammable hazards of compressed gases used in welding process

E. Securing of lines and regulators

F. Proper storing of all gases and liquids

Student Activities:

A. Practice securing equipment

B. Practice storing or locating equipment in proper location

WELDER SERIES

MASTER Technical Module No. WLD-S05

SUBJECT: **WELDING TECHNICIAN** **TIME: 5 HOURS**

- **DUTY:** **HOUSEKEEPING ACTIVTIES**
- **TASK:** Clean Work Area(s)

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Clean work area(s);
B. Use approved cleaning methods for welding equipment; and,
C. Perform final inspection of work area(s).

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-S5-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual, Latest Edition
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete all previous modules.

INTRODUCTION:

Clean work areas are essential to safety, quality control, and continued operations.

PRESENTATION OUTLINE:

Instructional Topics:

A. How to clean a welding shop operation
B. Use or non-use of compressed air
C. Use of approved cleaning materials
D. Segregation of gases and equipment in approved areas
E. General layout for efficiency
F. Knowledge of hazardous chemicals

Student Activities:

A. Recommend cleaning materials
B. Recommend cleaning methods
C. Have "wall to wall" cleaning activity

PRACTICAL APPLICATION:

Students will learn how to lay out a welding shop and clean it with continuous discipline.

EVALUATION AND/OR VERIFICATION:

A quiz will be given to verify knowledge and attitude concerning housekeeping.

SUMMARY:

Professional welders are known to operate with a dedication to cleanliness and neatness in every aspect of welding operations.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-T1) dealing with displaying a general understanding of emergency vehicle terminology.

WLD-S5-HO
Clean Work Area(s)
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Clean work area(s);
B. Use approved cleaning methods for welding equipment; and,
C. Perform final inspection of work area(s).

MODULE OUTLINE:

Instructional Topics:

A. How to clean a welding shop operation
B. Use or non-use of compressed air
C. Use of approved cleaning materials
D. Segregation of gases and equipment in approved areas
E. General layout for efficiency
F. Knowledge of hazardous chemicals

Student Activities:

A. Recommend cleaning materials
B. Recommend cleaning methods
C. Have "wall to wall" cleaning activity

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	← Tasks →												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with coworkers and supervisors						
E Work as a Team	E-1 Understand the roles of coworkers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW [illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

[illegible]

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties ← **Tasks** →

M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required; understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER SERIES

MASTER Technical Module No. WLD-T01

SUBJECT: WELDING TECHNICIAN TIME: 6 HOURS

- **DUTY:** **EMERGENCY VEHICLE TERMINOLOGY**
- **TASK:** Display a General Understanding of Emergency Vehicle Terminology

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the technologies and scope of company products; and,

B. Understand company systems and manufacturing processes.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-T1-HO)

REFERENCES:

TEXT:

Fundamentals of Modern Manufacturing – Materials, Processes, and Systems, Mitchell Groover, Prentice Hall, New Jersey, (ISBN 0-13-312182-8), Latest Edition

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition

Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition

Specific Company Safety Policy and Procedures Manual, Latest Edition

Specific Manufacturing Systems and Manufacturing Instructions, Latest Edition

OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses.

INTRODUCTION:

- Overview of the need for each employee to understand the basic technologies and scope of company products
- The need for each employee to understand the company's organization, systems, and manufacturing processes

PRESENTATION OUTLINE:

1. Company products and customer base
2. Company goals, employee goals, and quality plan
3. Company organization and support systems
4. Company production processes and technologies
5. Production work flow and job relationships
6. Company's competitive position in world market
7. Individual employee roles and contributions to company success
8. Future growth potential for individual and company goals or services

PRACTICAL APPLICATION:

Tour of company's facilities and support systems.

Presentation on product technologies and assembly processes.

EVALUATION AND/OR VERIFICATION:

Student will define his/her role (as an employee) in the manufacturing process, product quality, and customer satisfaction.

SUMMARY:

Students will understand the production work flow and recognize the important relationship of specific jobs to product quality and acceptance.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-T2) dealing with understanding the functions of equipment being assembled.

WLD-T1-HO
Display a General Understanding of Emergency Vehicle Terminology
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the technologies and scope of company products; and,

B. Understand company systems and manufacturing processes.

PRESENTATION OUTLINE:

1. Company products and customer base
2. Company goals, employee goals, and quality plan
3. Company organization and support systems
4. Company production processes and technologies
5. Production work flow and job relationships
6. Company's competitive position in world market
7. Individual employee roles and contributions to company success
8. Future growth potential for individual and company goals or services

WELDER SERIES

MASTER Technical Module No. WLD-T02

SUBJECT: WELDING TECHNICIAN TIME: 6 HOURS

- **DUTY: EMERGENCY VEHICLE TERMINOLOGY**
- **TASK:** Understand the Functions of Equipment Being Assembled

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the general production processes; and,

B. Understand specific equipment, major assemblies, and sub-assemblies.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-T2-HO)

REFERENCES:

TEXT:

Fundamentals of Modern Manufacturing – Materials, Processes, and Systems, Mitchell Groover, Prentice Hall, New Jersey, (ISBN 0-13-312182-8), Latest Edition

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition

Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition

Specific Company Safety Policy and Procedures Manual, Latest Edition

Specific Manufacturing Systems and Manufacturing Instructions, Latest Edition

OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following module:

WLD-T1 "Display a General Understanding of Emergency Vehicle Terminology"

INTRODUCTION:

- Employees should understand the flow of work and the importance of the job they perform
- Identifying the related work steps just before and just after their work station

PRESENTATION OUTLINE:

1. Purpose of major assemblies and sub-assemblies in product use, operation, and functionality
2. Potential for improvement in work flow or use of tools
3. Work team interactions and responsibilities
4. Team problem-solving and continuous improvement

PRACTICAL APPLICATION:

Equipment functionality has direct relationship to controls and accessories that may be installed by several teams. Improved understanding may lead to employee suggestions for improvements in use of tools and assembly methods.

EVALUATION AND/OR VERIFICATION:

Written examination on company products, assemblies, and sub-assemblies

SUMMARY:

Well informed employees are better prepared to suggest product improvements, and are more concerned about the total system performing to specifications.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-T3) dealing with understanding how components relate as a total system.

WLD-T2-HO
Understand the Functions of Equipment Being Assembled
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the general production processes; and,

B. Understand specific equipment, major assemblies, and sub-assemblies.

MODULE OUTLINE:

1. Purpose of major assemblies and sub-assemblies in product use, operation, and functionality
2. Potential for improvement in work flow or use of tools
3. Work team interactions and responsibilities
4. Team problem-solving and continuous improvement

WELDER SERIES

MASTER Technical Module No. WLD-T03

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **EMERGENCY VEHICLE TERMINOLOGY**
- **TASK:** Understand How Components Relate as a Total System

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the company's systems and subsystems; and,

B. Understand the importance of functional areas such as marketing, product design, purchasing, production planning, etc.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-T3-HO)

REFERENCES:

TEXT:

Specific Company Safety Policy and Procedures Manual, Latest Edition

Specific Manufacturing Systems and Manufacturing Instructions, Latest Edition

Fundamentals of Modern Manufacturing – Materials, Processes, and Systems, Mitchell Groover, Prentice Hall, New Jersey, (ISBN 0-13-312182-8), Latest Edition

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition

Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition

OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must complete the following modules:

WLD-T1	"Display a General Understanding of Emergency Vehicle Terminology"
WLD-T2	"Understand the Functions of Equipment Being Assembled"

INTRODUCTION:

- Overview on the need to understand the total functional sub-systems of the company in support of the product or service
- Use of systems and sub-systems by the employee

PRESENTATION OUTLINE:

1. The company organization
2. Functional staff and support activities
3. Systems and sub-systems
4. Computer information applications and their use
5. Design and documentation
6. Production planning (job orders and raw materials)
7. Financial and inventory/assets
8. Quality systems, corrective action reports, and continuous improvement
9. Marketing, warranty, and customer satisfaction
10. Human resources and employee programs
11. Safety and occupational health/wellness

PRACTICAL APPLICATION:

Employees should have a sound understanding of the company products, assembly and sub-assembly processes, quality and warranty policies, and health and wellness benefits offered by the employer.

EVALUATION AND/OR VERIFICATION:

Students (employees) will be asked to evaluate the importance and effectiveness of this company training.

SUMMARY:

Well informed employees identify with their employer in a positive way. Employees that understand the systems of the company, will use the informational and documentation features to increase their value added contributions to day-to-day operations and total company success.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-U1) dealing with demonstrating ability to lift 50 pounds.

WLD-T3-HO
Understand How Components Relate as a Total System
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the company's systems and subsystems; and,

B. Understand the importance of functional areas such as marketing, product design, purchasing, production planning, etc.

MODULE OUTLINE:

1. The company organization
2. Functional staff and support activities
3. Systems and sub-systems
4. Computer information applications and their use
5. Design and documentation
6. Production planning (job orders and raw materials)
7. Financial and inventory/assets
8. Quality systems, corrective action reports, and continuous improvement
9. Marketing, warranty, and customer satisfaction
10. Human resources and employee programs
11. Safety and occupational health/wellness

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLD PM0
072300

2104

2105

Duty U

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on llife of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 60 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-U1

WELDER SERIES
MASTER Technical Module No. WLD-U01

SUBJECT: **WELDING TECHNICIAN** **TIME: 4 HOURS**

- **DUTY:** **WELLNESS/PHYSICAL ABILITIES**
- **TASK:** Demonstrate Ability to Lift 50 Pounds

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the methods and physics involved in lifting;
B. Understand the mechanisms and limitations of lifting;
C. Be able to lift products safely in accordance with safe methods and physical limitations; and,
D. Use lift trucks and other lift-assist equipment in a safe manner.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-U1-HO)

REFERENCES:

TEXT:

Specific Company Safety Policy and Procedures Manual, Latest Edition
Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition

OTHER:

Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student should present a current statement of health.

INTRODUCTION:

- Overview of the potential for back and muscular injuries
- Need for realistic evaluation of capability
- Need to follow safe lifting methods

PRESENTATION OUTLINE:

1. Safety and industrial health statistics for back and muscular injuries from improper lifting techniques
2. Approved methods for safe lifting within the job description
3. Use of lift assist devices on the job
4. Need for individual assessment with full consideration for physical limitation and any prior injuries
5. Procedure for physical examination by company or private physician
6. Minimizing risk for company and the individual
7. Procedure for reporting personal injuries on the job

PRACTICAL APPLICATION:

In an effort to reduce risk to the employee and the company, it is important that the student (employee) have realistic evaluation of personal lift capability, using approved methods, and to understand the need for training in the safe methods of lifting advocated by the company.

EVALUATION AND/OR VERIFICATION:

Student (employee) will demonstrate safe lifting methods and the proper use of various lift-assist devices.

SUMMARY:

Some workers tend to volunteer for jobs that go beyond their physical limitations or capabilities. They need to understand the risks and realistically assess their capabilities, with the help of medical or industrial health specialists. Using approved lift methods and lift-assist equipment can reduce risk of back injuries. This is an area that requires careful study and evaluation by the employee and the employer.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-U2) dealing with demonstrating ability to tolerate heights up to 100 feet.

WLD-U1-HO

Demonstrate Ability to Lift 50 Pounds

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the methods and physics involved in lifting;
B. Understand the mechanisms and limitations of lifting;
C. Be able to lift products safely in accordance with safe methods and physical limitations; and,
D. Use lift trucks and other lift-assist equipment in a safe manner.

MODULE OUTLINE:

1. Safety and industrial health statistics for back and muscular injuries from improper lifting techniques
2. Approved methods for safe lifting within the job description
3. Use of lift assist devices on the job
4. Need for individual assessment with full consideration for physical limitation and any prior injuries
5. Procedure for physical examination by company or private physician
6. Minimizing risk for company and the individual
7. Procedure for reporting personal injuries on the job

WELDER SERIES

MASTER Technical Module No. WLD-U02

SUBJECT: WELDING TECHNICIAN TIME: 3 HOURS

- **DUTY:** **WELLNESS/PHYSICAL ABILITIES**
- **TASK:** Demonstrate Ability to Tolerate Heights up to 100 Feet

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand capability to tolerate and adjust to safe working conditions from Heights; and,

B. Understand safe working conditions above ground level.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-U2-HO)

REFERENCES:

TEXT:

Specific Company Safety Policy and Procedures Manual, Latest Edition
Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition.

OTHER:

Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of

required prerequisite courses. Student should present a current statement of health. Student must complete the following module:

WLD-U1 "Demonstrate Ability to Lift 50 Pounds"

INTRODUCTION:

- Welding is a hazardous occupation that also involves occasionally working from heights while secured in a safe manner
- All welders that accept such jobs should know safe and approved methods of work and types of work encountered at heights

---

PRESENTATION OUTLINE:

1. Types of work encountered at heights
2. Methods of securing individual and equipment
3. Methods of controlling movement
4. Backup and fail-safe systems
5. Methods of tolerating heights
6. Realistic assessment of capabilities and risks
7. Following OSHA and company approved procedures

PRACTICAL APPLICATION:

Welders will realistically accept their limitations for working at heights, and learn safe working procedures if they engage in such work.

EVALUATION AND/OR VERIFICATION:

Engage in low level demonstration of safety and security methods.

Examination and check out on safe working procedures at heights.

SUMMARY:

Welders that wish to accept work at heights should apprentice themselves to an expert worker and highly dedicated manager, to not only understand the methods, but to gradually condition themselves to the safe performance of this work.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-U3) dealing with ability to work from various positions while standing on concrete for extended periods.

WLD-U2-HO
Demonstrate Ability to Tolerate Heights up to 100 Feet
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand capability to tolerate and adjust to safe working conditions from Heights; and,

B. Understand safe working conditions above ground level.

MODULE OUTLINE:

1. Types of work encountered at heights
2. Methods of securing individual and equipment
3. Methods of controlling movement
4. Backup and fail-safe systems
5. Methods of tolerating heights
6. Realistic assessment of capabilities and risks
7. Following OSHA and company approved procedures

WELDER SERIES

MASTER Technical Module No. WLD-U03

SUBJECT: **WELDING TECHNICIAN** **TIME: 3 HOURS**

- **DUTY:** **WELLNESS/PHYSICAL ABILITIES**
- **TASK:** Ability to Work from Various Positions While Standing on Concrete for Extended Periods

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Understand the various positions the welder assumes while standing; and,
B. Understand the reasons for wearing personal protective equipment.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-U3-HO)

REFERENCES:

TEXT:

Specific Company Safety Policy and Procedures Manual, Latest Edition
Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition

OTHER:

Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand the principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must present a current statement of health. Students must complete the following modules:

WLD-U1	"Demonstrate Ability to Lift 50 Pounds"
WLD-U2	"Demonstrate Ability to Tolerate Heights up to 100 Feet"

INTRODUCTION:

- The standing position (one of its variations) is the most typical work position in industrial assembly and welding
- Worker needs to vary work position to lessen fatigue and maintain alertness
- Welders must wear appropriate personal protective equipment

---

PRESENTATION OUTLINE:

1. Methods of working from the standing position
2. Approved variations of the standing position
3. Placement of fixtures, tools, and gas bottles
4. Movement of welding apparatus or machine
5. Wearing the proper shoes is important to comfort as well as safety
6. Relaxation techniques to use during break periods
7. Working with a planned approach that reduces stress
8. Walking relaxes body tension

PRACTICAL APPLICATION:

Employees move around naturally if left to work in a fixed position

---

EVALUATION AND/OR VERIFICATION:

Student (employees) observe and record the actions of another group of workers engaged in separate tasks while standing.

Discussion of variation of standing positions as practiced by the study group - any observed unsafe actions and those most likely to cause fatigue.

SUMMARY:

The common deviations in standard positions of work need to be observed by the welder so he/she may follow the examples of the expert welders with the best welding techniques.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-U4) dealing with displaying ability to work in hot/cold environment for 8-10 hours.

WLD-U3-HO

Ability to Work from Various Positions While Standing on Concrete for Extended Periods

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the various positions the welder assumes while standing; and,

B. Understand the reasons for wearing personal protective equipment.

PRESENTATION OUTLINE:

1. Methods of working from the standing position
2. Approved variations of the standing position
3. Placement of fixtures, tools, and gas bottles
4. Movement of welding apparatus or machine
5. Wearing the proper shoes is important to comfort as well as safety
6. Relaxation techniques to use during break periods
7. Working with a planned approach that reduces stress
8. Walking relaxes body tension

WELDER SERIES

MASTER Technical Module No. WLD-U04

SUBJECT: WELDING TECHNICIAN **TIME: 3 HOURS**

- **DUTY:** **WELLNESS/PHYSICAL ABILITIES**
- **TASK:** Display Ability to Work in Hot/Cold Environment for 8-10 Hours

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the risks of working in hot/cold environment for extended periods; and,

B. Understand the need to wear protective equipment, and take appropriate measures to protect against heat-stroke or frost-bite in extreme temperatures.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-U4-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition
Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition

OTHER:

Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual, Latest Edition
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of required prerequisite courses. Student must present a current statement of health. Students must complete the following modules:

WLD-U1	"Demonstrate Ability to Lift 50 Pounds"
WLD-U2	"Demonstrate Ability to Tolerate Heights up to 100 Feet"
WLD-U3	"Ability to Work from Various Positions While Standing on Concrete for Extended Periods"

INTRODUCTION:

- An overview of the need for workers to protect themselves against the adverse conditions of hot and cold temperatures.

PRESENTATION OUTLINE:

1. The body's reaction to hot temperatures and radiation from the sun
2. Degree of bodily injury from heatstroke/sunstroke, sunburn,,
3. Preventive measures, protective clothing and first aid
4. The body's reaction to cold temperatures, frost-bite, and wind chill
5. Degrees of injury from cold temperatures and wind chill
6. Preventive measures, protective clothing, and first-aid
7. Medical follow-up following exposure

PRACTICAL APPLICATION:

Workers need to plan for the work day, with appropriate clothing, fluids to drink, and notification of work site supervisor should worker need an unscheduled break periods for rest and assessment of physical condition.

EVALUATION AND/OR VERIFICATION:

Review case studies of accidents that have occurred as a result of worker exposure to hot and cold temperatures

SUMMARY:

Workers should be cautioned when working in extreme temperatures not to become drowsy and fall asleep. Make sure they carry sufficient food and drink; and that they protect the skin from radiation, sunburn, or frost-bite.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-U5) dealing with presenting a history of documented regular attendance at work.

WLD-U4-HO
Display Ability to Work in Hot/Cold Environment for 8-10 Hours
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the risks of working in hot/cold environment for extended periods; and,

B. Understand the need to wear protective equipment, and take appropriate measures to protect against heat-stroke or frost-bite in extreme temperatures.

MODULE OUTLINE:

1. The body's reaction to hot temperatures and radiation from the sun
2. Degree of bodily injury from heatstroke/sunstroke, sunburn,
3. Preventive measures, protective clothing and first aid
4. The body's reaction to cold temperatures, frost-bite, and wind chill
5. Degrees of injury from cold temperatures and wind chill
6. Preventive measures, protective clothing, and first-aid
7. Medical follow-up following exposure

WELDER SERIES

MASTER Technical Module No. WLD-U05

SUBJECT: WELDING TECHNICIAN TIME: 3 HOURS

- **DUTY:** **WELLNESS/PHYSICAL ABILITIES**
- **TASK:** Present a History of Documented Regular Attendance at Work

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the need for prompt reporting to work; and,

B. Take pride in the professional responsibility displayed by a regular attendance schedule.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-U5-HO)

REFERENCES:

TEXT:

Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition

OTHER:

Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition

Specific Company Safety Policy and Procedures Manual, Latest Edition

OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition

Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition

Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of

required prerequisite courses. Student must present current statement of health. Student must complete the following modules:

WLD-U1	"Demonstrate Ability to Lift 50 Pounds"
WLD-U2	"Demonstrate Ability to Tolerate Heights up to 100 Feet"
WLD-U3	"Ability to Work from Various Positions While Standing on Concrete for Extended Periods"
WLD-U4	"Display Ability to Work in Hot/Cold Environment for 8-10 Hours"

INTRODUCTION:

- An overview of the pitfalls, safety hazards, and interruption of production that may occur if a key member of the work team does not report to work as scheduled.

PRESENTATION OUTLINE:

1. The worker's reputation of starting on time is one of reliability, delivery of work as promised, and ability to work as a team
2. Starting at the scheduled time may also be a reflection of dedication, lifestyle, and good health
3. Workers that are consistently late usually have a series of problems that need to be identified individually - if not addressed promptly, the worker may be released
4. If a lesser skilled supervisor or entry level worker has to fill in for a highly skilled worker, possible results are poor quality, accidents, machine maintenance problems, interruptions, and equipment down time

PRACTICAL APPLICATION:

The importance of good attendance at work cannot be over emphasized. The absence or tardiness of employees can create some work hazards, loss of production, and loss of revenue.

EVALUATION AND/OR VERIFICATION:

Students should check their class attendance records, and workers their "late starts" or absences - analyzing reasons for each

SUMMARY:

If an employee accepts a job with prescribed hours of work he/she must make every effort to be on the job on time or a few minutes early to facilitate the "hand off" from the previous shift. Disabled and handicapped workers have some of the best attendance records in industry.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (WLD-U6) dealing with applying wellness information to lifestyle to maintain health.

WLD-U5-HO
Present a History of Documented Regular Attendance at Work
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the need for prompt reporting to work; and,

B. Take pride in the professional responsibility displayed by a regular attendance schedule.

PRESENTATION OUTLINE:

1. The worker's reputation of starting on time is one of reliability, delivery of work as promised, and ability to work as a team
2. Starting at the scheduled time may also be a reflection of dedication, lifestyle, and good health
3. Workers that are consistently late usually have a series of problems that need to be identified individually - if not addressed promptly, the worker may be released
4. If a lesser skilled supervisor or entry level worker has to fill in for a highly skilled worker, possible results are poor quality, accidents, machine maintenance problems, interruptions, and equipment down time

WELDER SERIES

MASTER Technical Module No. WLD-U06

SUBJECT: **WELDING TECHNICIAN** **TIME: 8 HOURS**

- **DUTY:** **WELLNESS/PHYSICAL ABILITIES**
- **TASK:** Apply Wellness Information to Lifestyle to Maintain Health

---

OBJECTIVE(S):

Upon completion of this unit the student will be able to assess personal health and fitness levels by evaluation in lifestyles, fitness components, stress management, nutrition and weight control.

INSTRUCTIONAL MATERIALS:

MASTER Handout (WLD-U6-HO)

REFERENCES:

TEXT:

Wellness Concepts and Applications, Anspaugh, Hamrick and Rosato, Mosby, Latest Edition
Modern Welding, Althouse, Turnquist, Bowditch, Bowditch, The Goodheart-Wilcox Company, Inc., Tinley Park, IL, (ISBN 1-56637-330-1), Latest Edition

OTHER:

Occupational Safety Management and Engineering, Willie Hammer, Prentice Hall, (ISBN 0-13-629379-4), Latest Edition
Keller's Official OSHA Safety Handbook, J. J. Keller & Associates, Inc., Neenah, WI, (ISBN 1-897798-21-5), Latest Edition
Specific Company Safety Policy and Procedures Manual, Latest Edition
OSHA General Industry Requirements, U. S. Government Printing Office, Latest Edition
Safety in Welding, Cutting and Allied Processes, ANSI/ASC Z49.1-94, American Welding Society, Miami, FL, Latest Edition
Welding Inspection, American Welding Society, Miami, FL, Latest Edition

---

STUDENT PREPARATION:

Student must demonstrate appropriate communication skills and understand principles of basic physical science and mathematics as verified by placement test or completion of

required prerequisite courses. Student must present a statement of current health status. Student must complete the following modules:

WLD-U1	"Demonstrate Ability to Lift 50 Pounds"
WLD-U2	"Demonstrate Ability to Tolerate Heights up to 100 Feet"
WLD-U3	"Ability to Work from Various Positions While Standing on Concrete for Extended Periods"
WLD-U4	"Display Ability to Work in Hot/Cold Environment for 8-10 Hours"
WLD-U5	"Present a History of Documented Regular Attendance at Work"

INTRODUCTION:

- An overview of the factors that limit wellness and personal fitness
- The need for self improvement plans based upon personal information developed from this module

---

PRESENTATION OUTLINE:

1. Life scan profile
2. Heart factors and cardiovascular endurance
3. Cholesterol and blood sugar
4. Pulmonary assessment
5. Muscular and skeletal flexibility assessment
6. Muscular strength
7. Nutritional analysis

PRACTICAL APPLICATION:

Development of methods for improvement of overall health and wellness

---

EVALUATION AND/OR VERIFICATION:

Evaluation of lifestyle improvement plan, with scheduled follow-up evaluations

---

SUMMARY:

Employees that understand the factors of wellness tend to lead a healthy lifestyle for themselves and their families. They should also have minimum absence for illness and minimum absenteeism.

NEXT LESSON ASSIGNMENT:

This completes the Welding modules.

WLD-U6-HO

Apply Wellness Information to Lifestyle to Maintain Health

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to assess personal health and fitness levels by evaluation in lifestyles, fitness components, stress management, nutrition and weight control.

MODULE OUTLINE:

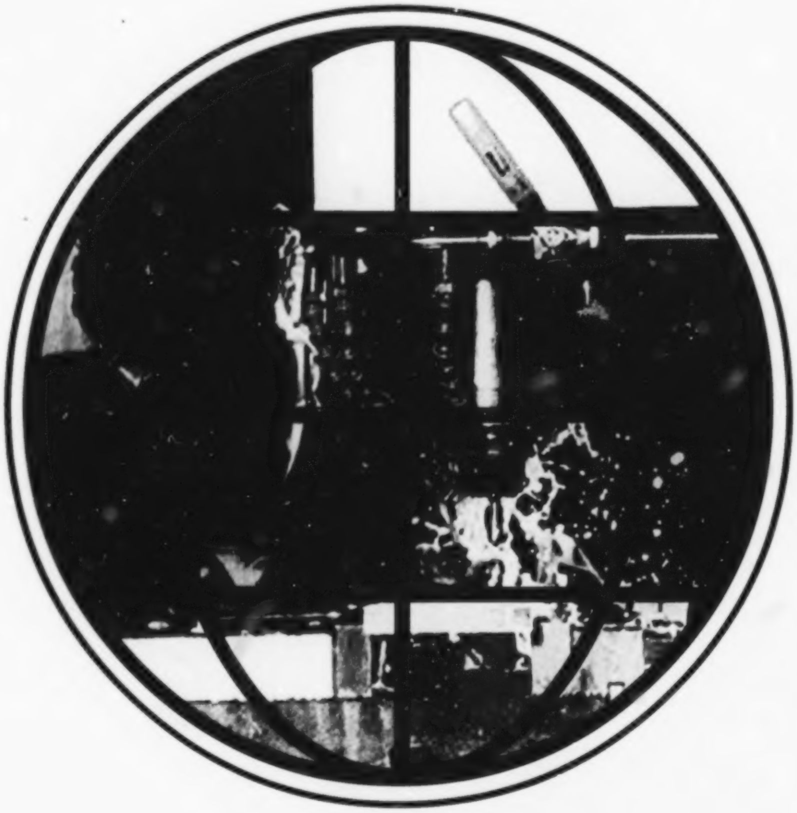
1. Life scan profile
2. Heart factors and cardiovascular endurance
3. Cholesterol and blood sugar
4. Pulmonary assessment
5. Muscular and skeletal flexibility assessment
6. Muscular strength
7. Nutritional analysis

MASTER

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY



Welding Series
STUDENT LABORATORY MANUAL
DUTIES A THROUGH K

Supported by the National Science Foundation's Advanced Technological Education Program

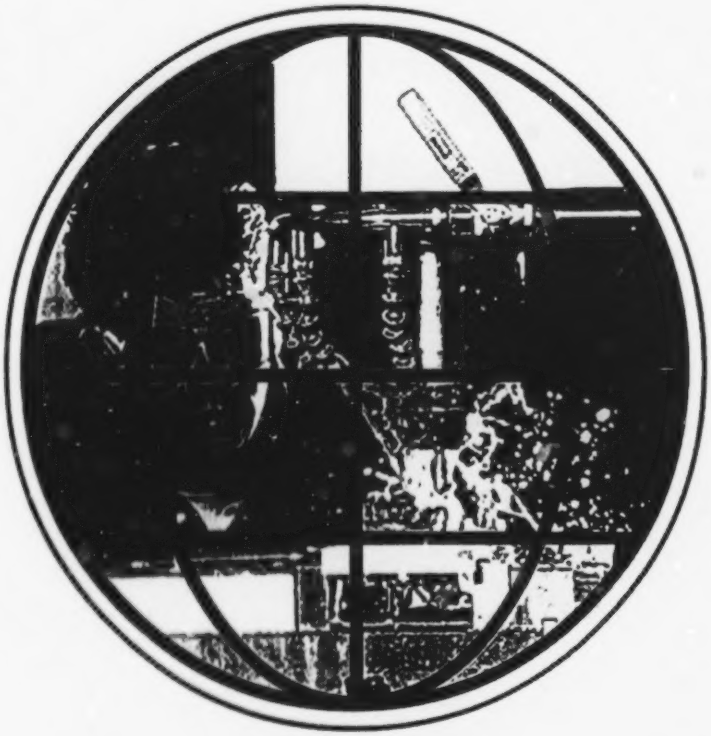
2120

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY



Welding Series
STUDENT LABORATORY MANUAL

Supported by the National Science Foundation's Advanced Technological Education Program

2130

This material is based upon work supported by the
National Science Foundation under Grant No. DUE-9553716

National Science Foundation
Advanced Technological
Education Program

"Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Foundation."

ACKNOWLEDGEMENTS

This project was made possible by the cooperation and direct support of the following organizations:

National Science Foundation - Division of Undergraduate Education
MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES
AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES
Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER
Central Florida Community College

Central Florica Community College
Dr. Charles R. Dessance, President
Dr. Hugh Rogers, Project Administrator

P.O. Box 1388
Ocala, FL 34478-1388
College phone: 352-873-5823
fax: 352-873-5883
Center phone: 407-384-2155

Manufacturing in Florida

During the past two decades, the Central Florida region near Florida's Space Coast, Melbourne, Cape Canaveral, Coala, Orlando, and the I-4 corridor to Tampa has experienced unprecedented economic growth. This growth has been especially evident in the fields of aerospace, electronics, laser electro-optics, and simulation enterprises. From 1990 to 1997 the area's population grew by more than 13 percent to approximately 4 million.

Manufacturing companies in the region now number more than 3000. The products manufactured range from aerospace to space launch equipment, advanced technology emergency vehicles, to sophisticated electronic and simulation components, circuit boards, laser equipment, wireless data systems, communication devices, and metals fabrication. Much of the nation's aerospace, satellite, and space facilities are concentrated in the region, including NASA, Lockheed Martin, E.G. and G. Inc., Boeing, McDonnell Douglas, Rockwell, Raytheon, Grumman, and Harris Corporation. Electronic companies such as Siemens, AT&T, Lucent, and Motorola serve both U.S. and export markets.

Central Florida, with three interstate highways (I-95, I-4, and I-75), is home to the University of Central Florida, its 27,000 students, and programs which include comprehensive engineering and engineering technology. Central Florida's growth has helped to fuel the State of Florida's growth to fourth largest state in the U.S. with a population of 14.6 million. By 2010 the state's population is projected to increase by more than 13 percent with 9 percent of its total workforce involved in manufacturing.

Central Florida Community College

Central Florida Community College (CFCC), serving a total of 6,000 students, offers a center of emphasis in Electronics, a Manufacturing Technology program with an internship requirement, an Industrial Maintenance/Machining program, a CADD program, and a Computer Design/Application program. Ocala, home of the college, has rapidly become an industrial center, with Lockheed Martin's Microelectronics Circuit Board Facility, and a second plant for Defense/Commercial Satellite Communications Manufacturing. E-One Corporation and other companies contribute to 17 percent of the local workforce being engaged in manufacturing.

Development Team

- **Project Coordinator**: Dr. Hugh Rogers, former Dean of Technical Education; served as the primary administrator and academic coordinator for the MASTER project. He also conducted the occupational skills profile interviews and benchmarked the welding instructional modules with review at four other colleges: Moraine Valley (Palos Hills, IL), IVY Tech (Terra Haute, Ind), Macomb Community College (Sterling Heights, MI), and Henry Ford Community College (Dearborn, MI).
- **Subject Matter** Experts: Mr Bill Rhodes and Mr Doug Wilson were responsible for developing skill standards and course/program materials for the welding technology components of the MASTER project. Other colleges and the American Welding Society.

Introduction:
STUDENT LABORATORY MANUAL

Prior to the development of this Student Laboratory Manual, MASTER project staff visited over 150 companies, conducted interviews with over 500 expert workers, and analyzed data from a national survey involving over 2800 participating companies. These investigations led to the development of a series of Instructor Handbooks, with each being fully industry-driven and specific to one of the technologies shown below:

Advanced CNC and CAM
Automated Equipment Repair
Computer Aided Design & Drafting
Conventional Machining
Industrial Maintenance
Instrumentation
LASER Machining
Manufacturing Technology
Mold Making
Tool And Die
Welding

Each Instructor's Handbook contains a collection of Technical Training Modules which are built around a Competency Profile for the specific occupation. **The Competency Profile which is the basis for this Student Laboratory Manual may be found on the following page (and on each of the tab pages in this book).**

This Student Laboratory Manual has been developed as an learning aid for both the instructor and for the student, and is intended to be used in conjunction with the Instructor's Handbook.

This Student Laboratory Manual is arranged by Duty groupings (Duty A, Duty B, etc.) with learning modules available for each Task Box on the Competency Profile.

This Student Laboratory Manual is supplied with an accompanying Instructor's Handbook for use by the instructor.

Each module in the Instructor's Handbook has a corresponding learning module in the Student Laboratory Manual.

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Interconvert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test weld to verify parameters								

WLD PM4
[illegible]

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 Perform GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Preheat joint, if required; understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel & stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Trouble-shoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Trouble-shoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		← Tasks →												
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/ Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe aluminum [illegible] classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	[illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

2142

2143

Duty A

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-A1-HO

Demonstrate Understanding of Safety Rules

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify safety rules;
B. Describe specific requirements for safety in welding operations;
C. Identify reference resources for welding safety information;
D. Discuss common ability to follow safety practices;
E. Demonstrate ability to follow safety practices; and,
F. Conduct a safety inspection of student work area.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. A lecture on safety and the hazards found when working in environments involving power equipment, high temperatures, high voltage electricity, combustible gases, high ventilation requirements, sparks and high intensity light from metal arcs.
2. A demonstration of safe practices in the welding lab.

WLD-A1-LE
Demonstrate Understanding of Safety Rules
Attachment 2: **MASTER** Laboratory Exercise

The purpose of this exercise is to learn to recognize hazards in the workplace. Many of the hazards which you will find are common safety practices by people who simply no longer see the danger.

The instructor will guide all students through the shop and welding facilities. Each student should write down, in the space provided on the form, as many safety hazards as are found.

It should be remembered that anyone can cause a hazard merely by failing to "see the mop bucket that sits in front of the fire exit" or "the hoses that are left on the floor". Such tunnel vision is the result of familiarity and demonstrates the importance of keeping a fresh perspective every day.

Due to the nature of this laboratory exercise, no universal answer key is presented.

Safety Hazards

Type	Location	Description

WLD-A1-LA
Demonstrate Understanding of Safety Rules
Attachment 3: **MASTER** Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated
2. Do not talk to anyone who is operating a machine, except in an emergency
3. Walk only in the designated traffic lanes
4. Dress appropriately; at the absolute minimum, you must have:
    a) No loose clothing, including ties;
    b) Long hair properly stowed and secured;
    c) No jewelry;
    d) Hard, closed-toe shoes;
    e) Eye protection (safety glasses); and
    f) Ear protection (plugs or headset).
5. Follow all institutional safety rules

WLD-A2-HO
Assume Personal Safety Standards for Self and Others
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Identify protective equipment and clothing;
B. Identify the location of others in coordination with the work performed;
C. Identify personal safety hazards of welding operations;
D. Discuss OSHA regulations concerning welding operations;
E. Explain the need for personal responsibility when working;
F. Operate exhaust system;
G. Shield others from "Arc Flash"; and,
H. Discuss the meaning and use of safety signs and symbols.

MODULE OUTLINE:

I. Assume Responsibility for the Personal Safety of Oneself and Others
  A. Safety is a way of life, not an option
  B. Always operate with alertness and safety foremost in mind
II. Develop a Personal Attitude Towards Safety
  A. The key to safety is individual safety
  B. Everyone must develop a safe attitude
  C. Each step of the operation must be carefully planned
III. Interpret Safety Manual Directives
  A. Read and understand safety manual
  B. Read machine operation instructions
IV. Comply with Established Safety Practices
  A. Personal safety
   1. Body: body must be protected from burns, cuts, and bruises
   2. Proper lifting technique
    a. Personal lifting
     1) Lift with the legs, not the back
     2) Proper physical position while lifting
     3) Proper clearance for carrying
     4) "Buddy system" for heavy lifting
    b. Equipment lifting
     1) Checking ratings for lifting devices
     2) Checking lifting points on lifted item
     3) Overhead clearance requirements
     4) Static lifting devices (slings, jack stands) should be used instead of moving lifting devices (jacks or forklifts) for actually holding heavy items up while working on them
  B. Eyes: always wear safety glasses

C. Head: keep long hair up; wear hard hat whenever required

D. Ears: wear protection to prevent damage from noise

E. Jewelry: no rings, watches, bracelets, necklaces (they can get caught in machinery and they are conductors of electricity)

F. Clothing: keep sleeves and pant legs rolled down; and ties, strings, and belts away from moving parts

G. No horse-play

H. Do not talk to someone while that person is operating a welding machine (unless for safety reasons)

I. Do not talk to someone while you are operating a welding machine (unless for safety reasons)

V. Identify and Control Common Machine Shop Hazards

A. Chip formation

B. Moving machine parts

C. Spills and other debris

D. Electrical lines

E. Hydraulic and pneumatic lines

VI. Cover specific safety policies of the company

WLD-A3-HO1
Describe the Purpose and Use of Protective Equipment
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- A. Identify safety issues unique to each type of welding;
- B. Describe the protective equipment used in welding operations;
- C. Explain the hazards which demand the use of protective equipment; and,
- D. Demonstrate the proper use and care of protective equipment.

MODULE OUTLINE:

- I. Wear Protective Safety Clothing as Required
  - A. Different types of safety clothing
    - 1. Protection from debris, cuts, and blows
      - a. Hard hat, safety glasses or goggles, work gloves when necessary
      - b. Sturdy footwear
      - c. Long sleeved shirt (sleeves rolled down and buttoned)
    - 2. Fire-retardant and fire-resistant clothing
      - a. Long sleeved, 100% cotton shirt
      - b. Long pants, 100% cotton
      - c. Leather chest protector, sleeves
    - 3. Optical filters to protect vision from intense light
      - a. Welding hood or goggles
      - b. Safety glasses or goggles for grinding
      - c. Tinted goggles for cutting torch work
    - 4. Breathing protection
      - a. Mask for dust, lint, smoke
  - B. Function and use of safety clothing
    - 1. Man made fiber clothing melts to worker's skin when ignited
    - 2. Prevents cuts and abrasions
    - 3. Keep shirt sleeves rolled down (hangs on equipment)
    - 4. Do not cuff pant legs (causes tripping)
    - 5. Do not wear jewelry
      - a. Catches in moving parts
      - b. Conducts electricity
    - 6. Do not wear neckties around moving parts of machinery
    - 7. Keep belts and apron strings tied and away from moving equipment
- II. Maintain and Use Protective Guards and Equipment on Machinery
  - A. Purposes of various guards
    - 1. Do not operate a machine until guards are in place
    - 2. Stop the machine to make adjustments or repairs

        3. Disconnect power before removing guards or panels
    - B. Evaluation and maintenance of protective equipment
        - 1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
        - 2. Do not use defective equipment
        - 3. Report defective or unsafe equipment immediately
        - 4. Make sure equipment is properly grounded
- III. Locate and Properly Use Signs, Devices, and Barriers
    - A. Install Safety Barriers
    - B. Use caution signs
    - C. Install lock and tag devices
    - D. Know where fire extinguishers are and how to use them
- IV. Use Lifting Aids When Necessary
    - A. Discuss recommended limits on single-person lifting
    - B. Discuss proper lifting methods (use of the legs)
        - 1. Use your legs (bend your knees)
        - 2. Keep the load close to your body
        - 3. Don't twist your body while lifting
        - 4. Make sure you can see where you are going
        - 5. Wear support belts
    - C. Discuss team-lifting
        - 1. Keep load the same height while lifting
        - 2. Move and lift on command
        - 3. Use dolly, wheelbarrow, or forklift
    - D. Determine lifting ratings of lifting equipment
        - 1. Know how your forklift operates
        - 2. Understand load characteristics (weight, size, shape)
    - E. Determine holding ratings of static lifting devices
    - F. Evaluate positions on the workpiece for placement of lifting and holding devices

WLD-A3-HO2

Describe the Purpose and Use of Protective Equipment

Attachment 2: **MASTER** Handout No. 2

The instructor will display as much protective equipment, such as welding masks, breathers, and hard hats as is practical and desirable. The instructor should demonstrate the proper use of this equipment.

WLD-A3-LA
Describe the Purpose and Use of Protective Equipment
Attachment 3: **MASTER** Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated
2. Do not talk to anyone who is operating a machine
3. Walk only in the designated traffic lanes
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules

WLD-A4-HO
Demonstrate Proper Handling of Hazardous Materials
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Use material safety data sheet (MSDS).
B. Identify signs and symbols on hazardous materials used in welding.
C. Discuss safety precautions to be observed with chemical hazards.
D. Discuss safety precautions to be observed welding gas hazards.
E. Demonstrate safe handling of hazardous materials in a work site.

MODULE OUTLINE:

I. Define Hazardous Materials According to the EPA
  A. What makes a material hazardous?
    1. It is hazardous if it causes harm to people or environment
II. Identify Hazardous Materials
  A. Material Safety Data Sheets (MSDS)
    1. Companies that make and distribute hazardous substances must provide your company with a MSDS on hazardous material
    2. MSDS developed by OSHA
    3. MSDS is part of the Hazard Communication Standard or Right to Know regulation
    4. MSDS is an easy reference for information on hazardous substances
  B. Information in MSDS
    1. What it is
    2. Who makes or sells it
    3. Where they are located
    4. Why it is hazardous
    5. How you can be exposed to the hazard
    6. Conditions that could increase the hazard
    7. How to handle the substance safely
    8. Protection to use while working with it
    9. What to do if exposed
    10. What to do if there is a spill or emergency
III. Know the Chemical and Physical Characteristics
  A. Corrosive
    1. Burns skin or eyes on contact
  B. Explosive
  C. Flammable
    1. Catches fire easily
  D. Radioactive
  E. Reactive

        1. Burns, explodes
        2. Releases toxic vapors
    F. Toxic
        1. Causes illness or possibly death

IV. Describe Storage, Transportation, Disposal
    A. Resource Conservation and Recovery Act (RCRA)
        1. Designed to reduce hazards of waste by tracking and regulating the substance
        2. Method used is called from cradle (creation) to grave (disposal)
        3. Tells what hazards are and how to keep track of them
        4. Sets up rules for handling wastes
        5. Provides strict documentation system to track them
    B. Your employer may have to report to the Environmental Protection Agency (EPA) on how the company is meeting the RCRA responsibilities
    C. The law requires companies that treat, store, or dispose of hazardous wastes to:
        1. Have a permit
        2. Identify and analyze new hazardous waste
        3. Provide a secure facility that keeps unauthorized people out
        4. Inspect the facility regularly
        5. Have a contingency plan for fire, explosion, and spills
        6. Practice emergency response for fire, explosion, spills
        7. Provide proper protective clothing and equipment
        8. Maintain EPA-required records

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated
2. Do not talk to anyone who is operating a machine
3. Walk only in the designated traffic lanes
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules

WLD-A5-HO
Demonstrate Knowledge of First Aid and CPR
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Discuss injury hazards which may occur in welding operations;
B. Describe the steps in assisting an injure person;
C. Describe the purpose and location of lock-out switches;
D. Outline the steps for performing CPR;
E. Perform first aid on a simulated injury; and,
F. Perform CPR on laboratory mannequin.

MODULE OUTLINE:

In this module students, seeking competency as a welder, will receive:

1. Lecture on common trauma injuries.
2. Lecture on burn injuries.
3. Lecture on breathing problems and cardiac arrest.
4. Performance demonstration on simulated wound(s).
5. Performance demonstration of cardiopulmonary resuscitation (CPR).

WLD-A6-HO

Practice Safety Precautions When Using Tools

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand tool safety;
B. Identify the proper tool to use for specific results;
C. Know the location of others when using tools;
D. List safety precautions for use of manual hand tools;
E. List safety precautions for use of a disc grinder;
F. List safety precautions for use of a bench grinder;
G. List safety precautions for use of a cut off saw;
H. List safety precautions for use of a band saw;
I. List safety precautions for use of a drill press;
J. List safety precautions for use of a hydraulic tool; and,
K. Practice proper maintenance of tools and equipment.

MODULE OUTLINE:

- I. Identify and Understand Safe Machine Operating Procedures
  - A. Never make adjustments on a machine while it is running
    - 1. Keep guards in place at all times
    - 2. Discontinue power before servicing
    - 3. Keep body parts clear of moving machinery
    - 4. Beware of sharp edges and flying debris
    - 5. Secure work pieces to prevent slipping
    - 6. Never stand directly in line with blades or knives
    - 7. Avoid kickback
    - 8. Feed stack into machine correctly
  - B. Electrical safety
    - 1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
    - 2. Stand on dry surface when working on electrical equipment
    - 3. Replace defective cords or plugs on equipment
    - 4. Use only those tools that are in good condition
    - 5. Use only carbon dioxide or dry chemical fire extinguishers for control of electrical fires
    - 6. Obtain help when working on equipment that may become energized
  - C. Avoid horseplay and practical jokes
  - D. Keep work area clean
- II. Demonstrate Safe Machine Operation
  - A. Good Housekeeping
    - 1. Materials and equipment should be stacked straight and neat

   2. Keep aisles and walkways clear of tools, materials, and debris
   3. Dispose of scraps and rubbish daily
   4. Clean up spills
   5. Clean and store hand tools

B. Good techniques
   1. Always walk – do not run
   2. Never talk to or interrupt anyone who is operating a machine
   3. Never leave tools or pieces of stock lying on table surface of a machine being used
   4. When finished with a machine, turn power OFF and wait until blades or cutters have come to a complete stop before leaving
   5. Check stock for defects before machining
      a. Do not use a machine until you understand it thoroughly
      b. Do not jam or rush stock into machinery
      c. Keep guards in place
      d. Make sure power is OFF before working on or servicing
   6. Keep hands and fingers away from moving parts
   7. Don't try to run too small a piece through the machine
   8. Use a brush to clean the surface table
   9. Keep your eyes focused on what you are working on
   10. Never use an air hose to blow debris off yourself or other workers
   11. Report faulty machinery to your supervisor
   12. Make sure machinery is properly grounded
   13. Never leave a piece of machinery that is running unattended
   14. Make sure stack is solidly supported

C. Miscellaneous materials
   1. Molten metal – can splash and cause serious burns
   2. Chemicals – burn or irritate the skin or cause eye damage
   3. Broken glass – causes cuts, can get in the eyes
   4. Pointed objects – knives, screwdrivers, punches, staples can puncture the skin
   5. Rough material – can scrape your skin and cause infections

D. Machinery
   1. Understand the safety regulations that involve the guarding of moving parts
   2. Know what parts of the equipment are energized
   3. Use all safeguards that have been provided to protect people from machinery
   4. See that all guards and protectors are in place before you start to work
   5. If you must work nearer, turn the machine off and lock out the power
   6. Never work in, around, or near dangerous, unguarded openings without wearing a safety belt and a lifeline that is properly seamed

E. One-fifth of all injuries on the job involve moving parts, machinery, or tools

---

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated
2. Do not talk to anyone who is operating a machine, except in an emergency
3. Walk only in the designated traffic lanes
4. Dress appropriately; at the absolute minimum, you must have:
   a) No loose clothing, including ties;
   b) Long hair properly stowed and secured;
   c) No jewelry;
   d) Hard, closed-toe shoes;
   e) Eye protection (safety glasses); and
   f) Ear protection (plugs or headset).
5. Follow all institutional safety rules

WLD-A7-HO
Demonstrate Proper Wearing and Use of Safety Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify safety factors;
B. Use face shields, safety glasses, protective apparel, and gloves;
C. Utilize proper breathing apparatus;
D. Demonstrate correct selection of safety equipment for a given task;
E. Demonstrate how the equipment is properly worn; and,
F. Demonstrate proper use of safety equipment for given welding tasks.

MODULE OUTLINE:

In this module students, seeking competency as a welder, will receive:

1. Lecture on welding safety equipment.
2. Demonstration of proper selection of welding safety equipment.
3. Wear personal protective equipment
    a. List personal protective equipment for shielded metal arc welding
    b. List personal protective equipment for gas tungsten arc welding
    c. List personal protective equipment for gas metal arc welding
    d. List personal protective equipment for flux cored arc welding
    e. List personal protective equipment for submerged arc welding
    f. List personal protective equipment for oxy fuel cutting
    g. List personal protective equipment for plasma arc cutting
    h. List personal protective equipment for air carbon arc gouging
    i. During shop work, wear applicable personal protective equipment at all times
    j. List personal safety equipment including clothing, shoes, etc.

WLD-A8-HO1
Create and Maintain a Safe Work Station
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- A. Understand that a clean work area is a safe work area;
- B. Protect self and others from arc flash;
- C. Demonstrate eye-safety precautions;
- D. Mark "Hot Work";
- E. Discuss the safety rules and procedures for using equipment;
- F. Identify common hazards in the welding shop, including:
  - 1. Improper machinery;
  - 2. Unguarded machinery;
  - 3. Tripping and falling;
  - 4. Electrical hazards;
  - 5. Improper lifting;
  - 6. Gas and chemical hazards;
- G. Explain the importance of "good housekeeping" in the shop; and,
- H. Explain the importance of storing material in a secure manner.

MODULE OUTLINE:

- I. Keep Work Areas Clean
  - A. Discuss the associated dangers of the most common hazards of the work place
    - 1. Tripping/falling hazards caused by spills, loose objects, etc.
      - a. Wipe up spills immediately
      - b. Dispose of scrap material
      - c. Do not wear loose clothing
      - d. Never roll sleeves or pants
      - e. Keep shoe strings tied
      - f. Position electrical cords and air hoses in safe areas
    - 2. Chemical hazards
      - a. Inhalants
      - b. Chemical burns
      - c. Flammable liquids
      - d. Explosives and explosive combinations
      - e. Toxins
    - 3. Electrical hazards
    - 4. High-pressure hazards
  - B. Discuss methods of avoiding and correcting common hazards
- II. Clean Machine/Hand Tools When Work Is Completed
- III. Put Tools Away When Work Is Finished
- IV. Keep Isles Clear of Equipment and Materials

V. Perform Preventive Maintenance as Required
A. Discuss that certain machines require extra precautions
B. Discuss how general maintenance enhances general safety
VI. Understand the Use of Material Safety Data Sheets (MSDS)
A. What chemicals have MSDS?
B. Where are the MSDS kept?
C. What information is on the MSDS?
1. Product identification
a. Specific product name and common name
b. Precautionary labeling
c. Safety equipment
d. Precautionary label statements
e. Storage color code
2. Hazardous components
3. Physical data
a. Boiling point
b. Vapor pressure
c. Melting point
d. Vapor density
e. Specific gravity
f. Evaporation rate
g. Solubility in water
h. Percentage of volatile components by volume
i. Appearance & odor
4. Fire and explosion hazard data
a. Flash point
b. NFPA 704M rating
c. Flammable limits (upper and lower)
d. Fire extinguishing media
e. Special fire-fighting procedures
f. Toxic gases produced
5. Health hazard data
a. Threshold limit value
b. Permissible exposure limit
c. Toxicity
d. Carcinogenicity
e. Effects of over-exposure
f. Target organs (those most affected by exposure)
g. Medical conditions aggravated by exposure
h. Routes of entry
i. Emergency and first-aid procedures
6. Reactivity data
a. Stability
b. Hazardous polymerization
c. Conditions to avoid

    d. Incompatible materials
    e. Decomposition products
7. Spill and disposal procedures
    a. Procedures: Spill or discharge
    b. Procedures: disposal
    c. EPA hazardous waste number
8. Protective equipment
    a. Ventilation
    b. Respiratory protection
    c. Eye/skin protection
9. Storage and handling precautions
    a. Storage color code
    b. Special precautions
10. Transportation data and additional information
    a. Domestic transport
        1) DOT shipping name
        2) Hazard class
        3) UN/NA
        4) Labels
        5) Reportable quantity
    b. International
        1) IMO shipping name
        2) Hazard class
        3) UN/NA
        4) Labels

WLD-A8-HO2

Create and Maintain a Safe Work Station

Attachment 2: **MASTER** Handout No. 2

STANDARDS OF PERFORMANCE:

Student shall demonstrate safe work habits in the work shop by:

Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand that a clean work area is a safe work area;
B. Protect self and others from arc flash;
C. Demonstrate eye-safety precautions;
D. Mark "Hot Work";
E. Discuss the safety rules and procedures for using equipment;
F. Identify common hazards in the welding shop, including:
    1. Improper machinery;
    2. Unguarded machinery;
    3. Tripping and falling;
    4. Electrical hazards;
    5. Improper lifting;
    6. Gas and chemical hazards;
G. Explain the importance of "good housekeeping" in the shop; and,
H. Explain the importance of storing material in a secure manner.

READING ASSIGNMENTS:

The following chapters are assigned to read from textbook:

Title

Manual Handling Methods; Lifting and Carrying; Equipment for Handling; Hand Trucks, Ropes, Chains and Slings; Fiber Ropes; Rope Slings

---

MODULE OUTLINE:

- I. Identify Safety Equipment Used When Working Aloft
  Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA
  - A. Equipment common to most personnel when working aloft
    - 1. Safety glasses
    - 2 Hard hat
    - 3. Safety belt or harness
- II. Describe How to Set up a Portable Ladder for Use
  - A. Portable ladder are broken down in the CFR's as metal and wood ladders
  - B Wood ladders see 29 CFR 1910.25
    - 1. Single section ladder
    - 2. Two section ladder
    - 3. Special use wood ladders
    - 4. Step ladder
  - C. Metal ladders see 29 CFR 1910.26
  - D. Set up 29 CFR 1910.26
    - 1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall
- III. Basic Safety Concerns While Working from Scaffolding
  Note: This module does not address scaffolding erection because special training is required
  - A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
  - B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
  - C. Never lean over the handrails to perform work
- IV. Concerns While Working from a Man Basket or Personnel Lift
  - A. Use basket or lift for employees and tools only, not freight
  - B. If basket has integral test weights insure weights are removed prior to lifting personnel
  - C. Hands must be inside basket while basket is moving
  - D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
  - E. Always inspect basket rigging prior to entry
  - F. Once the basket is in position it must be tied off if egress from the basket is required
- V. Demonstrate Proper Set up and Use of an Extension Ladder
  - A. Determine wall to base of ladder distance
  - B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

WLD-A8-LA
Create and Maintain a Safe Work Station
Attachment 3: **MASTER** Laboratory Aid

STANDARDS OF PERFORMANCE SAFETY:

Student shall demonstrate safe work habits in the work shop by:

- Using OSHA required safety equipment for the shop;
- Safety glasses;
- Hearing protection;
- Face shields;
- Gloves;
- Not wearing-rings, watches, jewelry, or loose clothing while operating equipment; and,
- Not participating in horse play or practical joking.

CONDUCT:

1. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

WLD-A9

Demonstrate Safety Precautions Regarding ARC Flash

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Explain danger to eyes from welding operations;
B. Discuss the function of safety equipment in protecting eyes from ARC flash; and,
C. Demonstrate the correct use of eye protection equipment.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on the danger of ARC flash.
2. Demonstration of ARC flash eye protection equipment.

WLD-A10-HO
Demonstrate Eye Safety Precautions
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Use safety glasses;
B. Use face shields during operations;
C. Discuss the dangers to eyes found in the welding environment; and,
D. Describe the safety equipment used for eye protection.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on eye physiology with emphasis on potential for light and/or heat damage.
2. Demonstration of eye hazards found in the welding environment.

WLD-A11-HO1
Perform Grinding and Brushing Technique Safety
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify the locations of people before operating equipment;
B. Identify the location of flammable or hazardous material before grinding;
C. Demonstrate the safe use of a disc grinder;
D. Demonstrate the safe use of a bench grinder; and,
E. Demonstrate safe technique(s) for brushing.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on safe grinding, brushing techniques.
2. Lab demonstration on grinding and brushing techniques.

WLD-A11-HO2

Perform Grinding and Brushing Technique Safety

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Identify and understand safe machine operating procedures; and,

b. Demonstrate safe machine operation.

MODULE OUTLINE:

I. Identify and Understand Safe Machine Operating Procedures
  A. Never make adjustments on a machine while it is running
    1. Keep guards in place at all times
    2. Discontinue power before servicing
    3. Keep body parts clear of moving machinery
    4. Beware of sharp edges and flying debris
    5. Secure work pieces to prevent slipping
    6. Never stand directly in line with blades or knives
    7. Avoid kickback
    8. Feed stack into machine correctly
  B. Electrical safety
    1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
    2. Stand on dry surface when working on electrical equipment
    3. Replace defective cords or plugs on equipment
    4. Use only those tools that are in good condition
    5. Use only carbon dioxide or dry chemical fire extinguishers for control of electrical fires
    6. Obtain help when working on equipment that may become energized
  C. Avoid horseplay and practical jokes
  D. Keep work area clean.

II. Demonstrate Safe Machine Operation
  A. Good housekeeping
    1. Materials and equipment should be stacked straight and neat
    2. Keep aisles and walkways clear of tools, materials, and debris
    3. Dispose of scraps and rubbish daily
    4. Clean up spills
    5. Clean and store hand tools
  B. Good techniques
    1. Always walk - do not run
    2. Never talk to or interrupt anyone who is operating a machine

3. Never leave tools or pieces of stock lying on table surface of a machine being used
4. When finished with a machine, turn power OFF and wait until blades or cutters have come to a complete stop before leaving
5. Check stock for defects before machining
    a. Do not use a machine until you understand it thoroughly
    b. Do not jam or rush stock into machinery
    c. Keep guards in place
    d. Make sure power is OFF before working on or servicing
6. Keep hands and fingers away from moving parts
7. Don't try to run too small a piece through the machine
8. Use a brush to clean the surface table
9. Keep your eyes focused on what you are working on
10. Never use an air hose to blow debris off yourself or other workers
11. Report faulty machinery to your supervisor
12. Make sure machinery is properly grounded
13. Never leave a piece of machinery that is running unattended
14. Make sure stack is solidly supported

C. Miscellaneous materials
1. Molten metal - can splash and cause serious burns
2. Chemicals - burn or irritate the skin or cause eye damage
3. Broken glass - causes cuts, can get in the eyes
4. Pointed objects - knives, screwdrivers, punches, staples can puncture the skin
5. Rough material - can scrape your skin and cause infections

D. Machinery
1. Understand the safety regulations that involve the guarding of moving parts
2. Know what parts of the equipment are energized
3. Use all safeguards that have been provided to protect people from machinery
4. See that all guards and protectors are in place before you start to work
5. If you must work nearer, turn the machine off and lock out the power
6. Never work in, around, or near dangerous, unguarded openings without wearing a safety belt and a lifeline that is properly seamed

E. One-fifth of all injuries on the job involve moving parts, machinery, or tools

WLD-A12-HO1
Maintain Adequate Ventilation
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand chemical hazards and MSDS;
B. Use ventilation systems;
C. Use proper breathing apparatus;
D. Recognize a closed work environment;
E. Identify the composition of a normal atmosphere;
F. Discuss the potential dangers to the normal atmosphere during welding operations; and
G. Describe the ventilation requirements for safe welding operations.

MODULE OUTLINE:

I. Keep Work Areas Clean
    A. Discuss the associated dangers of the lack of ventilation in the workplace
        1. Chemical Hazards
            a. Inhalants
            b. Chemical burns
            c. Flammable liquids
            d. Explosives and explosive combinations
            e. Toxins
        2. Electrical hazards
        3. High-pressure hazards
    B. Discuss methods of avoiding and correcting common hazards
II. Clean Machine/Hand Tools When Work Is Completed
III. Put Tools Away When Work Is Finished
IV. Keep Isles Clear Of Equipment And Materials
V. Perform Preventive Maintenance As Required
    A. Discuss that certain machines require extra precautions
    B. Discuss how general maintenance enhances general safety
VI. Understand the Use of Material Safety Data Sheets (MSDS)
    A. What chemicals have MSDS?
    B. Where are the MSDS kept?
    C. What information is on the MSDS?
        1. Product identification
            a. Specific product name and common name
            b. Precautionary labeling
            c. Safety equipment

    - e. Storage color code
2. Hazardous components
3. Physical data
    - a. Boiling point
    - b. Vapor pressure
    - c. Melting point
    - d. Vapor density
    - e. Specific gravity
    - f. Evaporation rate
    - g. Solubility in water
    - h. Percentage of volatile components by volume
    - i. Appearance and odor
4. Fire and explosion hazard data
    - a. Flash point
    - b. NFPA 704M rating
    - c. Flammable limits (upper and lower)
    - d. Fire extinguishing media
    - e. Special fire-fighting procedures
    - f. Toxic gases produced
5. Health hazard data
    - a. Threshold limit value
    - b. Permissible exposure limit
    - c. Toxicity
    - d. Carcinogenicity
    - e. Effects of over-exposure
    - f. Target organs (those most affected by exposure)
    - g. Medical conditions aggravated by exposure
    - h. Routes of entry
    - i. Emergency and first-aid procedures
6. Reactivity data
    - a. Stability
    - b. Hazardous polymerization
    - c. Conditions to avoid
    - d. Incompatible materials
    - e. Decomposition products
7. Spill and disposal procedures
    - a. Procedures: spill or discharge
    - b. Procedures: disposal
    - c. EPA hazardous waste number
8. Protective equipment
    - a. Ventilation
    - b. Respiratory protection
    - c. Eye/skin protection
9. Storage and handling precautions
    - a. Storage color code

b. Special precautions
10. Transportation data and additional information
   a. Domestic transport
      1) DOT shipping name
      2) Hazard class
      3) UN/NA
      4) Labels
      5) Reportable quantity
   b. International
      1) IMO shipping name
      2) Hazard class
      3) UN/NA
      4) Labels

WLD-A12-HO2
Maintain Adequate Ventilation
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Keep work areas clean;
b. Clean machine/hand tools when work is completed;
c. Put tools away when work is finished;
d. Keep isles clear of equipment and materials;
e. Perform preventive maintenance as required; and,
f. Understand chemical hazards and the use of Material Safety Data Sheets (MSDS).

MODULE OUTLINE:

I. Keep Work Areas Clean
    A. Discuss the associated dangers of the lack of ventilation in the workplace
        1. Chemical Hazards
            a. Inhalants
            b. Chemical burns
            c. Flammable liquids
            d. Explosives and explosive combinations
            e. Toxins
        2. Electrical hazards
        3. High-pressure hazards
    B. Discuss methods of avoiding and correcting common hazards
II. Clean Machine/Hand Tools When Work Is Completed
III. Put Tools Away When Work Is Finished
IV. Keep Isles Clear Of Equipment And Materials
V. Perform Preventive Maintenance As Required
    A. Discuss that certain machines require extra precautions
    B. Discuss how general maintenance enhances general safety
VI. Understand the Use of Material Safety Data Sheets (MSDS)
    A. What chemicals have MSDS?
    B. Where are the MSDS kept?
    C. What information is on the MSDS?
        1. Product identification
            a. Specific product name and common name
            b. Precautionary labeling
            c. Safety equipment
            d. Precautionary label statements
            e. Storage color code
        2. Hazardous components
        3. Physical data

   a. Boiling point
   b. Vapor pressure
   c. Melting point
   d. Vapor density
   e. Specific gravity
   f. Evaporation rate
   g. Solubility in water
   h. Percentage of volatile components by volume
   i. Appearance and odor

4. Fire and explosion hazard data
   a. Flash point
   b. NFPA 704M rating
   c. Flammable limits (upper and lower)
   d. Fire extinguishing media
   e. Special fire-fighting procedures
   f. Toxic gases produced
5. Health hazard data
   a. Threshold limit value
   b. Permissible exposure limit
   c. Toxicity
   d. Carcinogenicity
   e. Effects of over-exposure
   f. Target organs (those most affected by exposure)
   g. Medical conditions aggravated by exposure
   h. Routes of entry
   i. Emergency and first-aid procedures
6. Reactivity data
   a. Stability
   b. Hazardous polymerization
   c. Conditions to avoid
   d. Incompatible materials
   e. Decomposition products
7. Spill and disposal procedures
   a. Procedures: spill or discharge
   b. Procedures: disposal
   c. EPA hazardous waste number
8. Protective equipment
   a. Ventilation
   b. Respiratory protection
   c. Eye/skin protection
9. Storage and handling precautions
   a. Storage color code
   b. Special precautions
10. Transportation data and additional information
   a. Domestic transport

    1) DOT shipping name
    2) Hazard class
    3) UN/NA
    4) Labels
    5) Reportable quantity
b. International
    1) IMO shipping name
    2) Hazard class
    3) UN/NA
    4) Labels

WLD-A13-HO
Mark "Hot Work"
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Define "Hot Work";
B. Identify materials used when marking "Hot Work";
C. Demonstrate techniques for safety marking "Hot Work"; and,
D. Use safety precautions for self and others.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on the precautions to be taken when "Hot Work" is present in the shop.
2. Demonstration of proper marking and warning of "Hot Work".

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	[illegible] GMAW fillet and [illegible] welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

2161

2162

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

2183

2184

WLD-B1-HO
Apply Principles and Tools of Continuous Quality Improvement
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Recognize and solve problems; and,
B. Understand what worker empowerment is and how to effectively use.

MODULE OUTLINE:

Major Topics: **Worker Empowerment For Continuous Improvement**

I. What is Empowerment?
  A. Define Empowerment
    1. Philosophy that provides each employee an "opportunity" to be creative and make changes to the product and life-cycle processes.
    2. Opportunity includes both the authority to make changes and the authority to do what it takes to enable the change.
    3. Opportunity also means accepting responsibility for your decisions.
  B. Discuss what this means to the class.
    1. Empowerment is more complex than just giving permission to make changes.
    2. Authority or decision-making is a given right and can be easily taken away if proper responsibility is not demonstrated.
    3. Authority is often granted in steps. i.e. You can do up to this before getting further approval from management.
    4. Authority is not to be taken likely. Decision making decisions will be evaluated just as your production etc.
  C. Define Product life cycle processes1. Processes refer to those processes that define, design, develop, produce, deliver, sell, service, use of, disposal/recycling of our products and by-products.
II. Why is empowerment necessary?
  A. To effectively create quality!
  B. The Manufacturers' Alliance for Productivity and Innovation stated that " Organizations that empower employees as a part of their total management effort are twice as likely as other firms to report significant product or service improvement."
  C. Employees will be more motivated to accomplish organizational goals and objectives if they have the authority to make decisions.
III. 4 critical dimensions of empowerment
  A. Teamwork and communication
  B. The evolution of empowerment
  C. The bounds of empowerment

  - D. Education and training
- IV. Evolution of empowerment
  - A. Empowerment is not a quick fix, attitudes and habits are hard to change and come slowly.
  - B. Empowerment usually requires a change to the company infrastructure.
  - C. Effective empowerment demands personal growth in the areas of trust, technical knowledge.
  - D. Effective empowerment demands a maturing in accepting/using responsibility and authority.
  - E. The growth and maturing will be evolutionary and not accomplished instantly.
  - F. People need time to learn and adjust; some will need to grow more than others.
  - G. Certain individual can not or will not change and may require removal from the team.
- V. Discuss Workplace Environment Stages and compare traditional, employee involvement and employee empowerment.
- VI. Discuss Six conditions for empowerment - Is a trust-based model.
  - A. Character-Refers to what a person is. i.e. personal virtues such as Vision and enthusiasm, wisdom, courage, commitment, self-discipline, responsibility, persistence, patience, faith, compassion, trustworthiness, and honesty
  - B. Skills-Refers to what a person can do. i.e. personal knowledge of and proficiency in job related activities.
  - C. Win-win agreement-Refers to a social contract which delineates results (desired outcomes), guidelines (policies and procedures), resources (human machine, financial), accountability (performance standards and methods of evaluation), and consequences (organizational and personal impact). Basically an agreement that neither party is harmed at the expense of another. The most difficult and intricate condition.
  - D. Self-supervision-Refers to self-initiation and self-control with respect to the win-win agreement.
  - E. Structures-Refers to the organizational format and functional activities with respect to executing the win-win agreement.
  - F. Accountability-Refers to the establishment and acceptance of personal responsibility for affecting and producing results.
- VII. Barriers to success
  - A. Management not supportive, means giving up authority, control by senior management
  - B. Personnel issues
  - C. Supervisor resistance
  - D. Lack of transfer of power to teams
  - E. Misalignment (compensation and team structure)
  - F. Difficulty with new roles (team members, supervisors, or management)
- VIII. Bounds on empowerment
  - A. The new boundaries must be identified and communicated to team members to be effective.
    - 1. A new set of expectations must be developed.

2. Without careful planning and communication in these areas, misunderstanding and coordination problems will develop.

B. Responsibilities are typically assigned to the team, shared, or the supervisors.

1. Team Responsibilities: Survey of responsibilities and percent of teams with.

69% Safety and housekeeping
58% Assign tasks to members
53% Work with internal customers
46% Stop work for quality issues
45% Routing equipment maintenance
44% Vacation scheduling
42% Process improvements
38% Select work methods
34% External customers
33% Determine training needs
29% Set production goals

2. Shared responsibilities:

54% Select work methods
53% Determine training methods
51% Process improvements
49% Set production goals
44% Individual performance problems
44% Routine equipment maintenance
44% External customers

3. Supervisors responsibility:

70% Compensation decisions
55% Prepare and manage budgets
46% Performance appraisals
41% Individual performance problems

C. Key differences between traditional and empowered organizations

1. Empowered firms:
    - Accomplish work through independent teams.
    - Fosters an environment that develops, encourages, and rewards empowered people and teams.
    - Encourage people to build social and technical skills.
    - Align personal and firm goals and see that people understand their roles.
    - Exhibit a high level of individual and team self-management
    - Participate in work design, set direction, and resolve problems.
    - Provide people with the information they need - without asking

ELEMENT	TRADITIONAL ORGANIZATION	SELF-MANAGED TEAMS
Organizational Structure	Layered/Individual	Flat/Team
Job Design	Narrow Single Task	Whole process/multiple tasks
Management Role	Direct Control	Coach/Facilitate
Leadership	Top Down	Shared with Team
Information Flow	Controlled/Limited	Open/Shared
Rewards	Individual/Seniority	Team-based/Skills-based
Job Process	Managers plan, control, and improve processes	Team plan, control, and improve processes

WLD-B2-HO

Understand the Importance of Quality in the Manufacturing Process

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- A. Define TQM;
- B. Understand management philosophy for TQM;
- C. Define the concepts of TQM;
- D. Understand the cultural changes needed for TQM;
- E. Understand TQM organizations; and,
- F. Identify quality and the segments to achieve.

MODULE OUTLINE:

Major Topics: Total Quality Management

- I. Introduction to TQM
  - A. Definition of TQM
    - 1. A leadership philosophy
    - 2. A process, not product orientation
    - 3. A philosophy of continuous improvement
- II. Management Philosophy
  - A. Management responsible for the system, not the worker
- III. Concepts of TQM
- IV. Cultural changes for TQM
- V. TQM Organizations
- VI. Quality
  - A. Defining Quality
  - B. A Customer Right
  - C. Strategy for TQM Implementation
  - D. Planning and Organization for Quality
  - E. Plan-Do-Check-Act

WLD-B3-HO
Implement Concepts of Quality in the Workplace
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the concepts of continuous process improvement; and,

B. Work through a structured problem solving exercise to improve quality.

MODULE OUTLINE:

Major Topics: **Total Quality Management**

I. Continuous Process Improvement
  A. Principles
    1. Sources
    2. Causes
    3. Statistical Concept of Variation versus Engineering Concept
    4. Improving for stability
II. Structured Problem Solving
  A. Defining the Problem
  B. Implementing Containment Actions
  C. Identifying Root Causes
  D. Developing and Verifying the Solution
  E. Implementing the Solution
  F. Standardize the Improvement

WLD-B4-HO

Follow the Quality Plan and Recommend Improvements in Work Methods or Tooling

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the concepts of quality control;
B. Identify common investigative questions; and,
C. Identify sources of process variations.

MODULE OUTLINE:

Major Topics: Total Quality Management

I. Quality Control
  A. History and Concepts of Quality Control
    1. Corrective Actions
    2. Measurements
    3. Data Used
    4. Implementation
  B. Common Investigative questions
  C. Sources of Process Variations

WLD-B5-HO

Establish Methods, Plans and Procedures to Maintain Quality

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to establish methods, plans and procedures to maintain quality.

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 Perform GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDr.PM8
072396

2193

Duty C

2194

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Tasks

Duties													
M2 GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3 GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1 Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2 Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-C1-HO1

Be Prompt and on the Job in Accordance with Work Schedule

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the importance of work schedules;
B. Understand various scheduling methods;
C. Understand the need for promptness and readiness to work on time;
D. Be flexible and willing to help others in case of emergencies; and,
E. Recognize his/her role as a team member.

MODULE OUTLINE:

Instructional Topics:

A. Typical company policies and procedures on attendance and tardiness
B. Policies on disciplinary actions for repeated absences or tardiness
C. Personal planning methods for time scheduling, preparation for work, and travel to work to ensure timely arrival
D. Timely notification of employer in event of emergencies
E. Safety factors, job hazards, and actions to continue operations in event of emergencies
F. Contingency planning for continuation of operations
G. Job transition between shift crews to insure and provide continuation of operations
H. Team advisories for quality, production in planning, materials, and tools
I. Completing the production hand-off transition in an efficient and courteous manner
J. Job priorities and emergency operations plans
K. Personal habits and planning of leisure activities to prevent interferences with work schedule

Student Activities:

Prepare a work schedule that forecasts the cost impact on equipment down time, reduction of production, and project with one hour tardiness of the workforce at 5/ 10 /15% and absenteeism at one work day per month per employee

WLD-C1-H02
Be Prompt and on the Job in Accordance with Work Schedule
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10	Are grinders, saws, and similar equipment provided with appropriate safety guards? [29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)]	☐ YES	☐ NO
11	Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer?	☐ YES	☐ NO
12	Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"? [29 CFR 1910.106(d)(3)(ii)]	☐ YES	☐ NO
13	Are flammable liquids, such as gasoline, kept in an approved safety can? [29 CFR 1910.106(d)(2); 144(a)(1)]	☐ YES	☐ NO
14	Are work areas clean? [29 CFR 1910.22(a)]	☐ YES	☐ NO
15	Are work surfaces kept. dry or are appropriate means taken to assure the surfaces are slip-resistant? [29 CFR 1910.22(a)(2)]	☐ YES	☐ NO
16	Are all spilled materials or liquids cleaned up immediately? [29 CFR 1910.141(a)(3)(ii)]	☐ YES	☐ NO
17	Are aisles kept clean and free of obstructions? [29 CFR 1910.22(b)(1)]	☐ YES	☐ NO
18	Are fire aisles, access to stairways, and fire equipment kept clear? [29 CFR 1910.178(m)(14)]	☐ YES	☐ NO
19	Are exits kept free of obstructions? [29 CFR 1910.36(d)(1)]	☐ YES	☐ NO
20	Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems? [29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)]	☐ YES	☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or bums?

[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?

[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ______________________________

Audited by: ______________________________ **Date:** ______________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding

- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment

- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings

- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management

- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment

- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions

- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention

- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems

- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm hav a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers

- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping

- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections *must* be completed by (date) ______________

Routed to ______________________________ Date ______________

Repairs/corrections from above have been done.

Supervisor ______________________________ Date ______________ Page____ of___

BEST COPY AVAILABLE

WLD-C2-HO1

Value Honest Work Ethics, Dedication, and Responsibility in the Workplace

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Assess core values of the individual with those of the work group and corporation; and,

B. Understand the importance of personal ethics to product quality and production outcomes.

MODULE OUTLINE:

Instructional Topics:

1. A code of ethics for professionals
2. The process of values clarification
3. Permit some mistakes so employees can learn
4. Be concerned about small things as well as larger or major events
5. Demonstrate what you believe about ethics in your work
6. Do the right thing, with full consideration of your values
7. Stay out of ethical debt to others
8. Communicate with others
9. Understand the position of each person on the work team

Student Activities:

1. Discuss a case study in situational work ethics
2. Define professional integrity

WLD-C2-H02
Value Honest Work Ethics, Dedication, and Responsibility in the Workplace
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept. dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or burns?

[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?

[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ______________________________

Audited by: ______________________________ **Date:** ______________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding
- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment
- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management
- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment
- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions
- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention
- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems
- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm hav a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers
- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping
- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections *must* be completed by (date) ______________________

Routed to ______________________________ Date ______________

Repairs/corrections from above have been done.

Supervisor ______________________________ Date ______________ Page____ of___

BEST COPY AVAILABLE

WLD-C3-HO1
Demonstrate High Moral Values
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand that the act of hiring a new employee involves trust by the employer;
B. Understand how to work with honor and respect; and,
C. Follow the principles of honesty on the job.

MODULE OUTLINE:

Instructional Activities:

1. Continue individual values clarification
2. Meanings and applications of honesty in the workplace
3. Employees in a position of trust and responsibility
4. Working from a perspective of honor and respect

Student Activities:

1. Students will discuss the meaning of "honesty" on the job
2. Students will be asked to take a position on case studies of honesty reflected by the use of property, materials, time, reporting, production rates, and communications

WLD-C3-H02
Demonstrate High Moral Values
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(1)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept. dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or burns?
[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?
[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ____________________

Audited by: ____________________ **Date:** ____________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding
- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment
- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management
- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment
- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions
- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention
- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems
- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm have a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers
- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping
- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections *must* be completed by (date) ____________

Routed to ____________________ Date ____________

Repairs/corrections from above have been done.

Supervisor ____________________ Date ____________ Page____ of____

BEST COPY AVAILABLE

WLD-C4-HO1
Display a Neat and Clean Workplace
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the rationale for a clean workplace; and,
B. Apply the principles of planning to the layout of a safe and well-arranged area.

PRESENTATION OUTLINE:

Instructional Topics:

1. Locating and storing tools, fixtures, and raw materials (metals, electrodes, etc.) for efficiency
2. Scheduling of time for cleanup of area and preventive maintenance of tools
3. Scheduling preventive maintenance of machines and apparatus
4. Storage and work accessibility of gases, hoses, and regulators used in welding processes
5. Disposal of generated waste or scrap metal
6. Cleaning methods and tools in support of shop operation

Student Activities:

1. Students will inventory, reorganize, and clean a welding shop in disarray
2. A discussion on "lessons learned" will follow

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10	Are grinders, saws, and similar equipment provided with appropriate safety guards? [29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)]	☐ YES	☐ NO
11	Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer?	☐ YES	☐ NO
12	Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"? [29 CFR 1910.106(d)(3)(ii)]	☐ YES	☐ NO
13	Are flammable liquids, such as gasoline, kept in an approved safety can? [29 CFR 1910.106(d)(2); 144(a)(1)]	☐ YES	☐ NO
14	Are work areas clean? [29 CFR 1910.22(a)]	☐ YES	☐ NO
15	Are work surfaces kept. dry or are appropriate means taken to assure the surfaces are slip-resistant? [29 CFR 1910.22(a)(2)]	☐ YES	☐ NO
16	Are all spilled materials or liquids cleaned up immediately? [29 CFR 1910.141(a)(3)(ii)]	☐ YES	☐ NO
17	Are aisles kept clean and free of obstructions? [29 CFR 1910.22(b)(1)]	☐ YES	☐ NO
18	Are fire aisles, access to stairways, and fire equipment kept clear? [29 CFR 1910.178(m)(14)]	☐ YES	☐ NO
19	Are exits kept free of obstructions? [29 CFR 1910.36(d)(1)]	☐ YES	☐ NO
20	Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems? [29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)]	☐ YES	☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or burns?
[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?
[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ______________________________

Audited by: ______________________________ **Date:** ______________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding
- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment
- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management
- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment
- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions
- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention
- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems
- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm hav a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers
- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping
- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections must be completed by (date) ______________

Routed to ______________________________ Date ______________

Repairs/corrections from above have been done.

Supervisor ______________________________ Date ______________ Page____ of____

BEST COPY AVAILABLE

WLD-C5-HO1

Practice Careful Use and Maintenance of Tools and Equipment

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand that careful use means the conduct of safe welding operations with proper tools; and,

B. Understand that preventive maintenance means daily checkout, troubleshooting, and clean-up of equipment and surrounding area.

MODULE OUTLINE:

A. Classification of tools by intended purpose or use

B. Specified location of tools and equipment to perform the scope of work

C. Check-out of tools and equipment prior to each shift

D. Reporting of deficiencies, tagging, or replacement of equipment

E. Minor repairs

WLD-C5-H02
Practice Careful Use and Maintenance of Tools and Equipment
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise – that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept. dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or burns?
[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?
[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ______________________________

Audited by: ______________________________ **Date:** ______________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding
- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment
- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management
- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment
- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions
- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention
- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems
- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm have a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers
- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping
- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections *must* be completed by (date) ______________

Routed to ______________________________ Date ______________

Repairs/corrections from above have been done.

Supervisor ______________________________ Date ______________ Page____ of____

BEST COPY AVAILABLE

WLD-C6-HO1
Be Committed to Excellence and Quality
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Practice the selection and use of the right tools for the right job at the right time in the right location;

B. Understand the need for precision and quality in products produced or services delivered; and,

C. Be motivated to achieve only the highest quality through continuous improvement.

MODULE OUTLINE:

A. Problem solving for welders

B. Benchmarking with the best

C. Continuous improvement methods for welders

D. Control of variables in the welding processes

E. Verifications and inspections for quality weldments

WLD-C6-H02
Be Committed to Excellence and Quality
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or burns?
[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?
[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ______________________________

Audited by: ______________________________ **Date:** ______________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding

- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment

- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings

- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management

- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment

- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions

- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention

- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems

- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm have a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers

- ☐ Are appropriate fire extinguishers mounted, located, and identified so that they are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping

- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections must be completed by (date) ______________

Routed to ______________________________ Date ______________

Repairs/corrections from above have been done.

Supervisor ______________________________ Date ______________ Page ____ of ____

BEST COPY AVAILABLE

WLD-C7-HO1

Present a Good Company Image in Attire and Attitude

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand how impressions and public images are important to product Success; and,

B. Understand the significance of company employee attitude, as displayed in public, that may convey lack of respect and concern for customers perceptions.

MODULE OUTLINE:

1. Welder clothing and protective equipment
2. Actions of a professional versus carefree "party animal" caricature
3. Implications for company reputation and liability if customer has wrong impression of welder
4. Attitudes and demeanor that affect customer opinion of products and services
5. Appearance of equipment or mobile welding truck that influences customer opinion
6. Appropriate use of company logo and markings
7. Inappropriate clothing, bumper stickers, and markings

WLD-C7-H02

Present a Good Company Image in Attire and Attitude

Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept. dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or burns?

[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?

[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ____________________

Audited by: ____________________ **Date:** ____________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding

- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment

- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings

- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management

- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment

- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions

- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention

- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems

- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm have a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers

- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping

- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections must be completed by (date) ____________

Routed to ____________________ Date ____________

Repairs/corrections from above have been done.

Supervisor ____________________ Date ____________ Page ____ of ____

BEST COPY AVAILABLE

WLD-C8-HO1
Support a Positive Work Environment
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate positive attitude and active in support of quality goals; and,

B. Share resources to support fellow workers and work teams.

MODULE OUTLINE:

1. Definition of a positive work environment
2. Characteristics and indicators of a positive work environment versus a "negative" work environment
3. Worker attitudes and belief systems
4. Helping workers define needs and assisting workers to meet needs
5. Consensus on company goals and worker goals
6. The establishment of "win - win" situations for workers, work teams, and management.

WLD-C8-H02
Support a Positive Work Environment
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10 Are grinders, saws, and similar equipment provided with appropriate safety guards?
[29 CFR 1910.243(a)(1), (c)(l)-(4), (e)(1)(i)] ☐ YES ☐ NO

11 Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer? ☐ YES ☐ NO

12 Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"?
[29 CFR 1910.106(d)(3)(ii)] ☐ YES ☐ NO

13 Are flammable liquids, such as gasoline, kept in an approved safety can?
[29 CFR 1910.106(d)(2); 144(a)(1)] ☐ YES ☐ NO

14 Are work areas clean?
[29 CFR 1910.22(a)] ☐ YES ☐ NO

15 Are work surfaces kept dry or are appropriate means taken to assure the surfaces are slip-resistant?
[29 CFR 1910.22(a)(2)] ☐ YES ☐ NO

16 Are all spilled materials or liquids cleaned up immediately?
[29 CFR 1910.141(a)(3)(ii)] ☐ YES ☐ NO

17 Are aisles kept clean and free of obstructions?
[29 CFR 1910.22(b)(1)] ☐ YES ☐ NO

18 Are fire aisles, access to stairways, and fire equipment kept clear?
[29 CFR 1910.178(m)(14)] ☐ YES ☐ NO

19 Are exits kept free of obstructions?
[29 CFR 1910.36(d)(1)] ☐ YES ☐ NO

20 Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems?
[29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)] ☐ YES ☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or burns?
[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?
[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ____________________

Audited by: ____________________ **Date:** ____________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding

☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)

☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)

☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)

☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)

☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)

☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment

☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)

☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)

☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings

☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)

☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management

☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)

☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)

☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)

☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)

☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)

☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)

☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)

☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)

☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)

☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)

☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)

☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment

☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)

☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)

☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)

☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)

☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)

☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)

☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)

☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)

☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)

☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)

☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)

☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions

☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)

☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention

☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)

☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?

☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)

☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)

☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)

☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)

☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)

☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)

☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems

☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)

☐ If you have a supervised employee alarm system (that is, does the alarm hav a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers

☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)

☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)

☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping

☐ Are aisles marked? 29 CFR 1910.22(b)(2)
☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections *must* be completed by (date) ____________

Routed to ____________________ Date ____________

Repairs/corrections from above have been done.

Supervisor ____________________ Date ____________ Page____ of____

BEST COPY AVAILABLE

WLD-C9-HO1
Practice a Positive Attitude
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand basic needs of individuals and groups; and,

B. Understand the benefits of a positive approach to meeting those needs.

PRESENTATION OUTLINE:

1. Basic human needs as depicted in Maslow's hierarchy
2. Individual needs, family, and group needs
3. Importance of the relationships of honor and trust with others
4. The importance of recognition for a positive goal of a job well done versus recognition for being "bad" or "cool"
5. The company culture and individual acceptance or denial of this culture
6. Alternatives for the individual in denial of company culture to be discussed
7. Individual attitude toward the work, the workplace, and the co-workers
8. Attitude assessment , process and examples
9. Attitude change process and belief systems from the worker perspective

WLD-C9-H02
Practice a Positive Attitude
Attachment 2: **MASTER** Handout No. 2

Safety Incentives Program
General Safety Checklist

1 Are empty compressed gas cylinders appropriately marked and their valves closed?
[29 CFR 1910.253(b)(1)(ii), (5)(ii)(H)] ☐ YES ☐ NO

2 Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage?
[29 CFR 1910.253(b)($)(iii)] ☐ YES ☐ NO

3 Does type of PPE used match the needs of current operations?
[29 CFR 1910.132(d)(1)(i)] ☐ YES ☐ NO

4 Is each work area adequately ventilated? ☐ YES ☐ NO

5 Are exhaust hazards controlled from forklifts or other gas, or diesel powered equipment?
[29 CFR 1910.1000(a)] ☐ YES ☐ NO

6 Is the facility free of environmental hazards – dust, chemicals, radiation, welding rays, heat, cold, or excessive noise -- that result from working?
[29 USC 654, Sec. 5(a)(1)] ☐ YES ☐ NO

7 Are all hazardous chemicals appropriately labeled?
[29 CFR 1910.1200(f)(5)&(6)] ☐ YES ☐ NO

8 If hazardous waste is stored, are all hazardous waste requirements complied with? ☐ YES ☐ NO

9 Are rotating or moving parts of equipment guarded to prevent physical contact?
[29 CFR 1910.212(a)(1); 243] ☐ YES ☐ NO

10	Are grinders, saws, and similar equipment provided with appropriate safety guards? [29 CFR 1910.243(a)(1), (c)(1)-(4), (e)(1)(i)]	☐ YES	☐ NO
11	Are power tools used with the correct shield, guard, or attachment recommended by the manufacturer?	☐ YES	☐ NO
12	Are storage cabinets used to hold flammable liquids, labeled "Flammable-Keep Fire Away"? [29 CFR 1910.106(d)(3)(ii)]	☐ YES	☐ NO
13	Are flammable liquids, such as gasoline, kept in an approved safety can? [29 CFR 1910.106(d)(2); 144(a)(1)]	☐ YES	☐ NO
14	Are work areas clean? [29 CFR 1910.22(a)]	☐ YES	☐ NO
15	Are work surfaces kept. dry or are appropriate means taken to assure the surfaces are slip-resistant? [29 CFR 1910.22(a)(2)]	☐ YES	☐ NO
16	Are all spilled materials or liquids cleaned up immediately? [29 CFR 1910.141(a)(3)(ii)]	☐ YES	☐ NO
17	Are aisles kept clean and free of obstructions? [29 CFR 1910.22(b)(1)]	☐ YES	☐ NO
18	Are fire aisles, access to stairways, and fire equipment kept clear? [29 CFR 1910.178(m)(14)]	☐ YES	☐ NO
19	Are exits kept free of obstructions? [29 CFR 1910.36(d)(1)]	☐ YES	☐ NO
20	Do you control dusts vapors, gases, fumes, smoke, solvents. or mists which may be generated in your workplace through general dilution or local exhaust ventilation systems? [29 CFR 1910.94(a)(2)(ii); (b)(2); (c)(2); (d)(1)(ii), (5), (6)]	☐ YES	☐ NO

21 Are approved safety glasses required to be worn at all times in areas when there is a risk of eye injuries such as punctures, abrasions, contusions, or bums?

[29 CFR 1910.133(a)(2)] ☐ YES ☐ NO

22 Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might product flying materials or be subject to breakage?

[29 CFR 1910.133(a)(1)] ☐ YES ☐ NO

WORKPLACE AUDIT / INSPECTION REPORT
Welding Area

Location: ____________________

Audited by: ____________________ **Date:** ____________

Audit Item/Practice
Check (✓) if Item/Practice not in compliance

Welding

- ☐ Are only authorized and trained personnel permitted to use welding, cutting or brazing equipment? 29 CFR 1910.252(a)(2)(xiii)(C)
- ☐ Does each operator have a copy of the appropriate operating instructions and are they directed to follow them? 29 CFR 1910.253(a)(4), (d)(6), (f)(7)(A)
- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are pressure–reducing regulators used only for the gas and pressures for which they are intended? 29 CFR 1910.253(e)(6)(i)
- ☐ Is a check made for appropriate ventilation in and where welding or cutting is performed? 29 CFR 1910.252(c)(1)(iii), (2)–(13), (b)(4)(ii)
- ☐ When working in confined places, are environmental monitoring tests taken and means provided for quick removal of welders in case of an emergency? 29 CFR 1910.252(c)(4)

Equipment

- ☐ Are only approved apparatus (torches, regulators, pressure–reducing valves, acetylene generators, manifolds) used? 29 CFR 1910.253(a)(3)
- ☐ Is open circuit (No Load) voltage of arc welding and cutting machines as low as possible and not in excess of the recommended limits? 29 CFR 1910.254(b)(3)(i)–(iv)
- ☐ Is grounding of the welding machine frame and safety ground connections of portable machines checked periodically? 29 CFR 1910.254(d)(3); .255(b)(9), (c)(6)

Equipment Markings

- ☐ Is red used to identify acetylene (and other fuel–gas) hose, green for oxygen hose, and black for inert gas and air hose? 29 CFR 1910.253(e)(5)(i)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.101(b); .253(b)(1)(ii), (2)(iii), (5)(ii)(H)

Compressed Gas Cylinder Management

- ☐ Are compressed gas cylinders regularly examined for obvious signs of defects, deep rusting, or leakage? 29 CFR 1910.254(d)(4); .255(e)
- ☐ Is care used in handling and storage of cylinders, safety valves, relief valves, etc., to prevent damage? 29 CFR 1910.253 (b)(2)(ii), (5)(iii)(B)
- ☐ Are liquified gases stored and shipped valve–end up with valve covers in place? 29 CFR 1910.253(b)(5)(iii)(A)
- ☐ Before a regulator is removed, is the valve closed and gas released from the regulator? 29 CFR 1910.253(b)(5)(iii)(D)
- ☐ Are cylinders, cylinder valves, couplings, regulators, hoses, and apparatus kept free of oily or greasy substances? 29 CFR 1910.253(b)(5)(i)
- ☐ Are the cylinders kept away from elevators, stairs, or gangways? 29 CFR 1910.253(b)(2)(ii)
- ☐ Is it prohibited to use cylinders as rollers or supports? 29 CFR 1910.253(b)(5)(ii)(K)
- ☐ Is care taken not to drop or strike cylinders? 29 CFR 1910.253(b)(5)(ii)(B)
- ☐ Unless secured on special trucks, are regulators removed and valve–protection caps put in place before moving cylinders? 29 CFR 1910.253(b)(5)(ii)(D)
- ☐ Do cylinders without fixed hand wheels have keys, handles, or non–adjustable wrenches on stem valves when in service? 29 CFR 1910.253(b)(5)(ii)(E)
- ☐ Are empty compressed gas cylinders appropriately marked and their valves closed? 29 CFR 1910.253(b)(1)(ii), (2)(iii), (5)(ii)(H)
- ☐ Are fuel gas cylinders and oxygen cylinders separated by distance, fire resistant barriers, etc., while in storage? 29 CFR 1910.253(b)(4)(iii)

Personal Protective Equipment

- ☐ Is PPE functional and in good repair? Does it have ANSI or ASTM specifications marked on it? 29 CFR 1910.132(e)
- ☐ Are all employees required to use personal protective clothing and equipment when handling chemicals (gloves, eye protection, respirators, etc.)? 29 CFR 1910.132(a)
- ☐ Are employees exposed to the hazards created by welding, cutting, or brazing operations protected with personal protective equipment and clothing? 29 CFR 1910.252(b)(3)
- ☐ Is personal protective equipment provided and are all employees required to use PPE as needed to protect against eye and face injury? 29 CFR 1910.132(a); .133(a)(1)
- ☐ Are protective goggles or face shields provided and worn where there is any danger of flying particles or corrosive materials? 29 CFR 1910.133(a)(1)
- ☐ Are approved safety glasses required to be worn at all times in areas where there is a risk of eye injuries such as punctures, abrasions, contusions, or burns? 29 CFR 1910.133(a)(2)
- ☐ Are appropriate safety glasses, face shields, etc., used while using hand tools or equipment which might produce flying materials or be subject to breakage? 29 CFR 1910.133(a)(1)
- ☐ Are employees who need corrective lenses (glasses or contacts) in working environments having harmful exposures required to wear only approved safety glasses, protective goggles, or use other medically approved precautionary procedures? 29 CFR 1910.133(a)(3)
- ☐ Is appropriate foot protection required where there is the risk of foot injuries? 29 CFR 1910.132(a); .136(a)
- ☐ Is appropriate hand protection required where there is the risk of hand injury? 29 CFR 1910.132(a); .138(a)
- ☐ Are hard hats provided and worn where danger of falling objects exists? 29 CFR 1910.135(a)(1)
- ☐ Are hard hats inspected periodically for damage to the shell and suspension system? 29 CFR 1910.135(b)

Air emissions

- ☐ If welding creates hazardous air emissions, is the welding area appropriately marked to indicate this? 29 CFR 1910.252(c)(iv)(A)–(C)
- ☐ If welding creates hazardous air emissions, have ventilation or local exhaust systems been provided to keep fumes below the maximum allowable concentrations? 29 CFR 1910.252(c)(iii)

Fire Prevention

- ☐ Are precautions taken to prevent the mixture of air or oxygen with flammable gases, except at a burner or in a standard torch? 29 CFR 1910.253(a)(1)
- ☐ Are signs reading "DANGER NO SMOKING, MATCHES, OR OPEN LIGHTS" or the equivalent, posted in welding areas?
- ☐ Are provisions made to never crack a fuel–gas cylinder valve near sources of ignition? 29 CFR 1910.253(b)(5)(iii)(C)
- ☐ When welding is done on metal walls, are precautions taken to protect combustibles on the other side? 29 CFR 1910.252(a)(2)(x)
- ☐ Before hot work is begun, are used drums, barrels, tanks, and other containers so thoroughly cleaned that no substances remain that could explode, ignite, or produce toxic vapors? 29 CFR 1910.252(a)(3)(i)
- ☐ If welding gases are stored, are oxygen and acetylene separated by a 5–foot noncombustible barrier? 29 CFR 1910.253(b)(4)(i)–(iii)
- ☐ Are compressed gas cylinders kept away from sources of heat? 29 CFR 1910.253(b)(2)(i)
- ☐ Is combustible scrap, debris, and waste stored safely and removed from the work site promptly? 29 CFR 1910.252 (a)(2)(i), (vii), (xiv)(C)(2)
- ☐ Are fire watchers assigned when welding or cutting is performed in locations where a serious fire might develop? 29 CFR 1910.252(a)(2)(iii)(A), (d)(4)(iv)

Fire Alarm Systems

- ☐ If you have a non–supervised fire alarm system, is it tested bimonthly? 29 CFR 1910.165(d)(2)
- ☐ If you have a supervised employee alarm system (that is, does the alarm have a device that indicates system malfunction), is it tested yearly? 29 CFR 1910.165(d)(4)

Portable Fire Extinguishers

- ☐ Are appropriate fire extinguishers mounted, located, and identified so that the are readily accessible to employees? 29 CFR 1910.157(c)(1)
- ☐ Are all fire extinguishers inspected and recharged regularly, and noted on the inspection tag? 29 CFR 1910.157(e)
- ☐ Are portable fire extinguishers provided in adequate number and type? 29 CFR 1910.157(d)

Aisles/Housekeeping

- ☐ Are aisles marked? 29 CFR 1910.22(b)(2)
- ☐ Are aisle widths maintained? 29 CFR 1910.22(b)(1)
- ☐ Are aisles in good condition? 29 CFR 1910.22(b)(1)
- ☐ Are work areas clean? 29 CFR 1910.22(a)

Repairs/corrections *must* be completed by (date) ____________

Routed to ____________________ Date ____________

Repairs/corrections from above have been done.

Supervisor ____________________ Date ____________ Page ____ of ____

BEST COPY AVAILABLE

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties ← **Tasks** →

A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerance
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their efforts on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

Duty D

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		← Tasks →												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post-finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-D1-HO
Practice Being a Good Listener
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Explain the preparations necessary to be an active listener;
B. Describe how to stay involved as a listener;
C. Discuss the importance of listening in the classroom; and,
D. List the barriers to becoming a good listener.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. A presentation on listening skills, including:
    A. Preparation for listening,
    B. Staying involved as a listener,
    C. Keeping an open mind,
    D. Eliminating barriers to listening.
2. A class discussion group in which every student participates as a speaker and an "active" listener. Each student will be asked to list the main point of every other student speaker.

WLD-D2-HO
Demonstrate Good Reading, Comprehension and Writing Skills
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Read and discuss technical documents on welding;
B. Define important technical welding terms;
C. Explain the need for, and use of, written technical materials; and,
D. Write technical notes, using complete sentences.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture(s) containing word exercises on how to read and comprehend technical welding materials.
2. Presentation of technical job functions, responsibilities, and tasks that need to be interpreted and written and transmitted to others.
3. Methods of definition, analysis, and language of the trade that conveys precise meaning.

WLD-D3-HO
Document Manufacturing Processes
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Describe a simple welding manufacturing process;
B. Discuss the steps in a welding manufacturing process;
C. Define the terms in a welding manufacturing process; and,
D. When given specifications, document a welding manufacturing process.

MODULE OUTLINE:

In this module students, seeking competency as an entry level welder, will receive:

1. Lecture on the purposes and techniques for documenting welding manufacturing processes.
2. A description of the layout of welding manufacturing work stations
3. A typical sequence of operations
4. Instructions on documenting a typical welding manufacturing process.

WLD-D4-HO
Prepare a Recommendation for Continuous Improvement
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Describe the steps in a continuous improvement program;
B. Discuss the importance of communication in continuos improvement;
C. Outline the parts of a written recommendation; and,
D. Prepare the data for a continuous improvement recommendation.

MODULE OUTLINE:

I. Continuous Process Improvement
- A. Principles
  - 1. Sources
  - 2. Causes
  - 3. Statistical concept of variation vs. engineering concept
  - 4. Improving for stability

II. Structured Problem Solving
- A. Defining the problem
- B. Implementing containment actions
- C. Identifying root causes
- D. Developing and verifying the solution
  - 1. Implementing the solution
  - 2. Standardize the improvement

III. Quality Control
- A. History and concepts of Quality Control
  - 1. Corrective actions
  - 2. Measurements
  - 3. Data used
  - 4. Implementation
- B. Common investigative questions
- C. Sources of process variations

WLD-D5-HO
Prepare a Summarized Priority List of Work Responsibilities
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Explain the need for a priority list of work responsibilities;
B. Discuss how work responsibilities are determined; and,
C. Describe the steps in preparing a priority list of work responsibilities.

MODULE OUTLINE:

1. The need for work priorities
2. How to identify work priorities
3. Criteria for ranking work priorities
4. Creation of summarized work priority lists
5. Priority lists and production methods
6. Work priorities and KANBAN
7. Work schedules and just-in-time methods
8. Sharing resources with the work team

WLD-D6-HO
Display Ability to Follow Directions, Give Directions And Accept Constructive Criticism
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Explain the importance of following direction and instructions of others in the production of quality work;

B. Discuss the ability to convey clear directions when explaining work to others; and,

C. Describe the need to accept, understand, and use constructive criticism in the production of quality work.

MODULE OUTLINE:

1. Listening to directions
2. Understanding directions clearly, and asking questions when uncertain.
3. The importance of clarity to the production of quality work.
4. The need to convey clear directions to others on the job when needed.
5. The use of welding terms and definitions
    a. Follow verbal instructions
    b. Follow written details
    c. Prepare time and job cards (reports & records)
6. The need to accept and give constructive criticism while maintaining good working relationships with others.
7. The methods of conflict resolution generally accepted in the workplace.

WLD-D7-HO
Demonstrate Positive Communication Skills with Co-Workers and Supervisors
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Discuss the importance of communications on the job;

B. Describe the conditions for positive communication to take place;

C. Discuss the role one's attitude plays in positive communication; and,

D. Adapt to changing job or work conditions with a positive approach in communicating with one's supervisors.

MODULE OUTLINE:

1. The use of positive communication skills
2. Workers attitudes and beliefs
3. The need of individual positive reinforcement
4. Goals and positive reinforcement
5. Incentives for quality work

WELDER ... **that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.**

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW [illegible] on various [illegible] in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

Duty E

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-E1 and WLD-E2-HO
Understand the Roles of Co-Workers
Respect Peer Relationships
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Understand and apply the concepts of teams and team building;
B. Apply principles and tools of continuous quality improvement;
C. Understand the importance of quality in manufacturing process;
D. Understand the roles of team members; and,
E. Respect peer relationships.

MODULE OUTLINE:

I. Definition of Team-A group of people working together to achieve common goals and objectives
  - Teamwork is planned because it results from preparation and organization
  - The nucleus of team building is trust
  - One cornerstone of TQ is a team-based structure
  - Synergy – The whole (team) is greater than the sum of its parts (members)

I. Major elements of team synergy
  - Listening and clarifying (concentrate on what is being said)
  - Supporting (create a positive climate)
  - Quality (make a personal commitment to improve)
  - Acceptance (respect other member's viewpoints)
  - Feedback (honest communication)

II. Achieving positive team synergy
  - Getting to know team members

III. Need for a team
  - Most problems occur across functional lines
  - 85% of teams are cross-functional
  - Change is critical to enable an organization to remain competitive in today's world
  - Increasing quality and productivity main reasons for teams

IV. Advantages of teamwork
  - Improved skills – by accessing more talent, expertise, and technical competence
  - Improved communication – communication is both vertical and lateral, is across department lines, more ideas, mutual respect.
  - Improved participation – boosts morale, allows for buy-in to changes, higher job satisfaction

- Improved effectiveness – solutions more likely to be implemented, people have process ownership

V. Team Size
  A. Three basic types of teams
    1. Quality Council – Normally high level functional leaders/managers. The council is responsible for establishing and sustaining commitment, direction, and energy for the organization's quality improvement.
    2. Work Unit – A group of employees that are responsible for the entire process, including such items as meeting technical specs, schedules, basic production problems, and interface with to some degree, with suppliers and external customers. Supervisors and functional experts take on the role as facilitators and coaches.
    3. Cross Functional – A special team put together to address specific situations that require knowledge and expertise from different fields. Team selection normally chosen from those that are affected by the problem, that possess knowledge or expertise related to the problem, and that will be involved with carrying out the solution. Cross functional teams have two distinct advantages; most use a consensus

VI. Roles of Team Members
  - Responsibilities
  - Accountability

WLD-E3-HO
Share Resources to Accomplish Necessary Tasks
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Define resources that are individually held and commonly held in production operations;

B. Demonstrate how resources can be more economically applied, with greater force, and with more lasting effect if they are shared by workers; and,

C. Explain the responsibility and outcomes of sharing resources.

MODULE OUTLINE:

I. Characteristics of an Effective Team
  - The atmosphere is informal and relaxed, without obvious tension
  - Everyone participates in the discussion
  - The team's task is understood and accepted by the members
  - Members listen to each other; each idea is given a hearing.
  - The team is comfortable with disagreement and does not avoid conflict simply to keep everything in agreement.
  - Decisions are reached by consensus.
  - Criticism is frequent, frank, and relatively comfortable with no personal attacks.
  - People are free to express their feelings and ideas on the team's problems.
  - When action is taken, clear assignments are made and accepted.
  - The leader does not dominate, nor does the team.
  - The team is self-conscious about how it functions and examines how it is performing.
  - Team members can recognize and can work with a variety of personalities
  - Each team member is aware of the skills of the other members and how these skills can be applied to reach the team's goals.

I. Reasons Why Teamwork and Sharing is Crucial for Effectiveness/Excellence
  - Is a crucial element of the empowerment process.
  - Allows for the pooling or complement of each others skills.
  - Not all change results in improvement.
  - A change (improvement) in one area may result in an impact for another area.

II. Conditions for an Effective Team
  - Interdependence – Working on problems that each person has a stake. Teamwork is crucial.
  - Effective leadership – The leader will take risks to improve group performance.
  - Joint Decision – All members agree to participate.

- Equal influence – Each member has an equal vote, equal say. Teams must become proficient in both problem-solving and decision making processes.

III. Three Main Roles for Team Members

- Group task. Initiator-contributor, information seeker, opinion seeker, opinion giver, elaborator, coordinator, orienter, evaluator critic, energizer, procedural technician, recorder
- Group maintenance. Encourager, harmonizer, compromiser, gate keeper and expediter, standard setter, group observer, follower.
- Individual. Team player, aggressor, blocker, recognition seeker, self-professor, playboy, dominator, help seeker, special interest pleader

IV. Importance of sharing resources to improve mission accomplishment

WLD-E4-HO
Facilitate the Work Ethic by Completing Tasks On Time and Accurately
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Encourage good work ethics;
B. Maintain time and work attendance;
C. Encourage honesty, quality work and high standards; and,
D. Provide a fair rate of work at high quality for the invested time.

MODULE OUTLINE:

1. Why be concerned about work ethics?
   A technician or craftsman's reputation has great value (to be enhanced or diminished). Responsibility to employer for quality work performed in a timely manner without defect.
2. What is a fair rate of work?
   Supply, demand, and ethics. Team roles and responsibilities.

WLD-E5 and WLD-E6-HO
Be Involved with Problem Solving
Apply Creative Thinking
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Enable students to experience and solve problems with various methods and tools;
B. Encourage proper definition of the problem; and,
C. Understand root cause failure analysis.

MODULE OUTLINE:

Students will receive information on:

1. Problem definition
2. Determining facts pertaining to this problem
3. Problem indicators
4. Major considerations pertaining to the problem
5. Affinity method
6. Pareto chart
7. Cause-effect diagrams
8. The scientific method
9. Cost-benefits method
10. Creative thinking
11. Consideration of alternatives
12. Testing of recommended solutions
13. Trial and follow-up
14. Design and experiments

WLD-E7 and WLD-E8-HO
Support a Positive Attitude
Encourage Good Feelings and Morale
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Encourage an attitude of work that is geared toward positive achievement; and,

B. Promote high morale and good feeling among the work force instead of negative attitudes that may become barriers.

MODULE OUTLINE:

Students will receive information on the following:

1. The basis for trust and confidence
2. Employer belief systems and outcomes in the workplace
3. Case studies where employee morale made a difference

WLD-E9 and WLD-E10-HO
Understand Purpose and Goals of the Organization
Apply Creative Thinking
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Understand the process of developing company purposes and goals; and,
B. Understand the planning and organizing of work in an organization with teams.

MODULE OUTLINE:

Students will receive information on the following:

1. The goals process
2. Company vision – a shared experience
3. Purposes of the enterprise
4. Means of accountability
5. Goods, work tasks, and work teams
6. A robust enterprise
7. The house of quality

WLD-E11, WLD-E12, and WLD-E13-HO
Be Willing to Lead in Areas of Knowledge and Expertise
Demonstrate Willingness to Learn New Methods and Skills
Demonstrate Good Personal Relations Skills
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this module the student will be able to:

A. Understand leadership and be willing to lead in areas of knowledge and expertise
B. Be willing to learn new methods and skills
C. Understand the need for good personal relations and interpersonal skills

---

MODULE OUTLINE:

Students will receive information on the following:

1. Definition of leadership
2. Leadership – situations and circumstances
3. Is knowledge all there is?
4. Leadership success is related to style, meeting needs, and maintaining good interpersonal relations
5. How is leadership learned?
6. Is a good leader a role model?
7. What values does the leader need?
8. Does the leader share resources and ideas?
9. Where does the leader change?
10. Are there levels of leadership and new responsibility?
11. Can leadership be distributed?
12. Does a leader need new methods and skills?
13. How important are human relation and interpersonal skills?

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	[illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

[illegible]

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties ← **Tasks** →

M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

2265

WLD-F1-HO
Exhibit Understanding of Basic Arithmetic Functions
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform operations and applications with real numbers;
B. Perform addition operations with whole numbers;
C. Perform subtraction operations with whole numbers;
D. Perform multiplication operations with whole numbers;
E. Perform division operations with whole numbers;
F. Utilize hand-held calculators for problem solving with whole numbers; and,
G. Understand the roots of numbers and the percent base.

MODULE OUTLINE:

Major Topics

I. The hand-held calculator - Operations with real numbers
  A. Whole numbers
II. Estimation
  A. Addition and subtraction
  B. Multiplication and division
III. Problem solving: Using calculators
  A. Whole numbers
IV. The roots of numbers as the opposite of powers
V. The percent base and how to solve for each variable

WLD-F2-HO
Exhibit Understanding of Converting Fractions and Decimals
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform operations and applications with fractions and decimals;
B. Perform addition operations with fractions and decimals;
C. Perform subtraction operations with fractions and decimals;
D. Perform multiplication operations with fractions and decimals;
E. Perform division operations with fractions and decimals; and,
F. Utilize hand-held calculators for problem solving with fractions and decimals.

MODULE OUTLINE:

Major Topics

I. The Hand-Held Calculator - Operations with Fractions
    A. Fractions: Percent (%) forms
II. Estimation of Fractions
    A. Addition and Subtraction
    B. Multiplication and Division
III. Problem Solving: Using Calculators
    A. Fractions: Percent (%) forms
    B. Fractions: Decimal forms

WLD-F3-HO1

Demonstrate Practical Mathematics in the Use of Measurement Tools

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand Industrial Concepts of measurement;
B. Demonstrate ability to correctly solve problem applications;
C. Understand the proper utilization of measuring tools; and,
D. Demonstrate ability to properly use measuring tools.

MODULE OUTLINE:

Major Topics

I. Industrial Concepts of Measurement
    A. Approximate and Exact Numbers
    B. Precision
    C. Accuracy
    D. Tolerance
    E. Significant Numbers
    F. Absolute and Relative Error
    G. Problem Solving Applications
II. Measuring Tools and Problem Solving
    A. Tape Measure
    B. Steel Tape
    C. Vernier Caliper
    D. Micrometers

WLD-F3-HO2
Demonstrate Practical Mathematics in the Use of Measurement Tools
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the use of metrology in manufacturing;
b. Discuss the Inch system of measurement;
c. Discuss the Metric system of measurement;
d. Discuss semi-precision and precision measurement; and,
e. Discuss the following: precision, reliability, discrimination, and accuracy.

MODULE OUTLINE:

I. Discuss the Use of Metrology in Manufacturing
  A. Discuss the function and reason for measurements in manufacturing
  B. Discuss the changes (metrology related) in manufacturing today
    1. Interchangeable manufacture
    2. World trade
    3. High precision
II. Discuss the Inch System of Measurement
  A. Discuss fractional (scale) dimensions for linear measurement
  B. Discuss decimal dimensions for linear measurement
  C. Convert fractional to decimal
    1. Review mathematical conversion method
    2. Fractional/decimal conversion charts
  D. Practice and demonstration of skills listed above
III. Discuss the Metric System of Measurement
  A. Discuss the units of measure commonly used in the metric system
  B. Convert inch to metric
    1. Review mathematical method (1 inch = 25.4 mm)
    2. Conversion charts
  C. Practice and demonstration of skills listed above
IV. Discuss Semi-Precision and Precision Measurement
  A. Discuss the difference between semi-precision and precision measurement
    1. Semi-precision measurements are 1/64" (.5mm) or greater
    2. Precision measurements are less than 1/64" (.5mm)
  B. Discuss the five categories of precision measurement
    1. Outside measurement
    2. Inside measurement
    3. Depth measurement
    4. Thread measurement
    5. Height measurement

V. Discuss the Following Measurement Terms: Accuracy, Precision, Reliability, and Discrimination
  A. *Accuracy* - whether or not something is made according to standard. (The standard for manufacturing is the blueprint.)
  B. *Precision* - the degree of exactness required for an application or design requirement
  C. *Reliability* - the ability to consistently obtain the desired result
  D. *Discrimination* - the degree that a measuring instrument divides its basic unit of length

WLD-F3-HO3
Demonstrate Practical Mathematics in the Use of Measurement Tools
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Identify basic semi-precision measuring tools;
b. Identify precision measuring tools;
c. Justify use of particular measurement tools based on tool characteristics;
d. Identify error possibilities in measurement tool selection; and,
e. Demonstrate proper care of precision measuring tools.

MODULE OUTLINE:

I. Describe and Discuss the Following Semi-Precision Measuring Tools
   A. Steel rules
   B. Calipers
   C. Squares
II. Describe and Discuss the Following Precision Measuring Tools
   A. Micrometers (outside, inside and depth)
   B. Verniers (calipers and height gage)
   C. Gages (small hole, telescope, fixed, and dial bore)
III. Justify Use of Particular Measurement Tools Based on Tool Characteristics
   A. What tolerance is required by the print?
   B. What physical characteristics of the part influence tool selection?
   C. What is the discrimination of the tool?
   D. How much time is available for part measurement/inspection?
   E. Will the tool be used by itself or in conjunction with some other tool?
   F. What is the most reliable tool for this application?
IV. Identify Error Possibilities in Measurement Tool Selection
   A. Part not being produced to specifications
   B. Too much time spent trying to measure correctly by not having the right tool
V. Demonstrate Proper Care of Precision Measuring Tools
   A. Storage
   B. Handling
   C. Cleaning

WLD-F3-HO4
Demonstrate Practical Mathematics in the Use of Measurement Tools
Attachment 4: **MASTER** Handout No. 4

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Measure with steel rules (metric and inch);
- b. Measure with micrometers;
- c. Measure with comparison measuring instruments (e.g., calipers, telescope gages);
- d. Measure with direct measuring instruments (e.g., vernier, dial and digital instruments); and,
- e. Measure with fixed gages (go and no-go gages).

MODULE OUTLINE:

- I. Discuss the Importance of Learning and Practicing Proper Measurement Techniques
  - A. Show the video "Measuring Tools"
  - B. Give each student a copy of the handout "Proper Measuring Techniques"
- II. Discuss and Demonstrate Proper Measurement Techniques Using the Steel Rule
- III. Discuss and Demonstrate the Use of Micrometer Type Measuring Instruments
  - A. Outside micrometers
  - B. Inside micrometers
  - C. Depth micrometers
  - D. Practice and demonstration of skills listed above
- IV. Discuss and Demonstrate the Use of Transfer Type Measuring Instruments
  - A. Spring calipers (inside and outside)
  - B. Telescope gages
  - C. Small hole gages
  - D. Practice and demonstration of skills listed above
- V. Discuss and Demonstrate the Use of Direct Measuring Instruments
  - A. Vernier calipers
  - B. Dial calipers
  - C. Digital calipers
  - D. Practice and demonstration of skills listed above
- VI. Discuss the Purpose of Fixed Gages and Demonstrate Their Use
  - A. Cylindrical plug and ring gages
  - B. Taper plug and ring gages
  - C. Snap gages
  - D. Thread plug gages
  - E. Practice and demonstration of skills listed above
- VII. Complete Practical Exercises on all above material

WLD-F3-LA
Demonstrate Practical Mathematics in the Use of Measurement Tools
Attachment 5: **MASTER** Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated
2. Do not talk to anyone who is operating a machine
3. Walk only in the designated traffic lanes
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and
    f. Ear protection (plugs or headset)
5. Follow all institutional safety rules

WLD-F4-HO1
Inter-Convert Metric/English Measurements
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the concepts of ratios;
B. Understand the concepts of proportions;
C. Understand the concepts of measures (linear, area, capacity, weight);
D. Show proficiency in the English system;
E. Show proficiency in the Metric system;
F. Understand Integers; and,
G. Demonstrate ability to solve problems in these areas.

MODULE OUTLINE:

Major Topics

I. The Concept of Ratios
  A. A numerical Comparison
  B. Percent as a Ratio
  C. Equivalent Fractions
  D. Problem Solving Applications
II. The Concept of Proportions
  A. The Equality of Ratios
  B. Direct Relationships
  C. Inverse Relationships
  D. Problem Solving Applications
III. Measurement Concepts: Selecting/Counting/Units
  A. Linear Measures
  B. Area Measures
  C. Capacity Measures
  D. Weight Measures
IV. The English System
V. The Metric System
VI. Problem Solving Applications
VII. The Integers
  A. The meaning of Signed Numbers
  B. The Real Number Line Graph
  C. Operations with Integers
  D. Problem Solving Applications

WLD-F4-HO2

Inter-Convert Metric/English Measurements

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the use of metrology in manufacturing;
b. Discuss the Inch system of measurement;
c. Discuss the Metric system of measurement;
d. Discuss semi-precision and precision measurement; and,
e. Discuss the following: precision, reliability, discrimination, and accuracy.

MODULE OUTLINE:

I. Discuss the Use of Metrology in Manufacturing
    A. Discuss the function and reason for measurements in manufacturing
    B. Discuss the changes (metrology related) in manufacturing today
        1. Interchangeable manufacture
        2. World trade
        3. High precision
II Discuss the Inch System of Measurement
    A. Discuss fractional (scale) dimensions for linear measurement
    B. Discuss decimal dimensions for linear measurement
    C. Convert fractional to decimal
        1. Review mathematical conversion method
        2. Fractional/decimal conversion charts
    D. Practice and demonstration of skills listed above
III. Discuss the Metric System of Measurement
    A. Discuss the units of measure commonly used in the metric system
    B. Convert inch to metric
        1. Review mathematical method (1 inch = 25.4 mm)
        2. Conversion charts
C. Practice and demonstration of skills listed above
IV. Discuss Semi-Precision and Precision Measurement
    A. Discuss the difference between semi-precision and precision measurement
        1. Semi-precision measurements are 1/64" (.5mm) or greater
        2. Precision measurements are less than 1/64" (.5mm)
    B. Discuss the five categories of precision measurement
        1. Outside measurement
        2. Inside measurement
        3. Depth measurement
        4. Thread measurement
        5. Height measurement

V. Discuss the Following Measurement Terms: Accuracy, Precision, Reliability, and Discrimination

- A. *Accuracy* - whether or not something is made according to standard. (The standard for manufacturing is the blueprint.)
- B. *Precision* - the degree of exactness required for an application or design requirement
- C. *Reliability* - the ability to consistently obtain the desired result
- D. *Discrimination* - the degree that a measuring instrument divides its basic unit of length

WLD-F4-HO3
Inter-Convert Metric/English Measurements
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Identify basic semi-precision measuring tools;
b. Identify precision measuring tools;
c. Justify use of particular measurement tools based on tool characteristics;
d. Identify error possibilities in measurement tool selection; and,
e. Demonstrate proper care of precision measuring tools.

MODULE OUTLINE:

I. Describe and Discuss the Following Semi-Precision Measuring Tools
    A. Steel rules
    B. Calipers
    C. Squares
II. Describe and Discuss the Following Precision Measuring Tools
    A. Micrometers (outside, inside and depth)
    B. Verniers (calipers and height gage)
    C. Gages (small hole, telescope, fixed, and dial bore)
III. Justify Use of Particular Measurement Tools Based on Tool Characteristics
    A. What tolerance is required by the print?
    B. What physical characteristics of the part influence tool selection?
    C. What is the discrimination of the tool?
    D. How much time is available for part measurement/inspection?
    E. Will the tool be used by itself or in conjunction with some other tool?
    F. What is the most reliable tool for this application?
IV. Identify Error Possibilities in Measurement Tool Selection
    A. Part not being produced to specifications
    B. Too much time spent trying to measure correctly by not having the right tool
V. Demonstrate Proper Care of Precision Measuring Tools
    A. Storage
    B. Handling
    C. Cleaning

WLD-F4-HO4
Inter-Convert Metric/English Measurements
Attachment 4: **MASTER** Handout No. 4

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Measure with steel rules (metric and inch);
- b. Measure with micrometers;
- c. Measure with comparison measuring instruments (e.g., calipers, telescope gages);
- d. Measure with direct measuring instruments (e.g., vernier, dial and digital instruments); and,
- e. Measure with fixed gages (go and no-go gages).

MODULE OUTLINE:

- I. Discuss the Importance of Learning and Practicing Proper Measurement Techniques
    - A. Show the video "Measuring Tools"
    - B. Give each student a copy of the handout "Proper Measuring Techniques"
- II. Discuss and Demonstrate Proper Measurement Techniques Using the Steel Rule
- III. Discuss and Demonstrate the Use of Micrometer Type Measuring Instruments
    - A. Outside micrometers
    - B. Inside micrometers
    - C. Depth micrometers
    - D. Practice and demonstration of skills listed above
- IV. Discuss and Demonstrate the Use of Transfer Type Measuring Instruments
    - A. Spring calipers (inside and outside)
    - B. Telescope gages
    - C. Small hole gages
    - D. Practice and demonstration of skills listed above
- V. Discuss and Demonstrate the Use of Direct Measuring Instruments
    - A. Vernier calipers
    - B. Dial calipers
    - C. Digital calipers
    - D. Practice and demonstration of skills listed above
- VI. Discuss the Purpose of Fixed Gages and Demonstrate Their Use
    - A. Cylindrical plug and ring gages
    - B. Taper plug and ring gages
    - C. Snap gages
    - D. Thread plug gages
    - E. Practice and demonstration of skills listed above
- VII. Complete Practical Exercises on all above material

WLD-F4-LA
Inter-Convert Metric/English Measurements
Attachment 5: **MASTER** Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated
2. Do not talk to anyone who is operating a machine
3. Walk only in the designated traffic lanes
4. Dress appropriately; at the absolute minimum, you must have:
    a. No loose clothing, including ties;
    b. Long hair properly stowed;
    c. No jewelry;
    d. Hard, closed-toe shoes;
    e. Eye protection (safety glasses); and
    f. Ear protection (plugs or headset).
5. Follow all institutional safety rules

WLD-F5-HO
Perform Practical Mathematical Applications Relevant to Area of Work
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate proficiency in algebraic operations;
B. Understand Laws of Exponents;
C. Understand Scientific Notation;
D. Solve basic equations;
E. Solve formulas through substitution and with variables;
F. Solve linear equations;
G. Understand the systems of linear equations;
H. Understand the basic concepts of Trigonometry such as:
  - Ratios and right angles;
  - naming trigonometric ratios;
  - Functions for given angles and Angles for given functions;
  - Proficiency in calculator usage to solve trig functions;
I. Understand right triangle applications;
J. Understand and solve problems in angular measures;
K. Understand and solve problems with circles;
L. Understand and solve problems with geometric shapes; and,
M. Understand and solve problems with geometric solids.

MODULE OUTLINE:

Major Topics

I. Algebraic Operations
  A. Addition of Algebraic Expressions
  B. Subtraction of Algebraic Expressions
  C. Multiplication of Algebraic Expressions
  D. Division of Algebraic Expressions
  E. Problem Solving Applications
II. Laws of Exponents
  A. Multiplication
  B. Division
III. Scientific Notation
IV. Solving Equations: Introduction
  A. Addition/Subtraction Principles
  B. Multiplication/Division Principles
  C. Combined Operations
  D. Problem Solving Applications

V. Solving Formulas: Introduction
  A. Substitution
  B. Solving for a Variable
  C. Problem Solving Applications
VI. Solving Linear Equations
  A. The Coordinate Plane
  B. Locating Points: Ordered Pairs
  C. Graphing Procedures
  D. Slope/Intercept
  E. Problem Solving Applications
VII. Solving Systems of Linear Equations
  A. Graphing Procedures
  B. Substitution Procedures
  C. Elimination of a Variable
  D. Problem Solving Applications
VIII. Introductory Trigonometry
  A. Ratios and Right Angles
  B. Naming Trigonometric Ratios
  C. Functions for Given Angles
  D. Angles for Given Functions
  E. Calculator Skills with Trig Functions
  F. Problem Solving Applications
IX. The Right Triangle-Applications
  A. Ratios and Proportions
  B. Problem Solving Techniques
  C. Problem Solving Applications
X. Angular Measures
  A. The Protractor/Units
  B. Naming Angles/Triangles
  C. The Pythagorean Theorem
  D. Complimentary/Supplementary Angles
  E. Problem Solving Applications
XI. The Circle
  A. Properties of Circles - Common Terms
  B. Circumference
  C. Arc Length/Cords/Tangents
  D. Problem Solving Applications
XII. Geometric Shapes - Area Measures
  A. The Circle: Sectors and Segments
  B. The Ellipse
  C. Common Polygons
  D. Problem Solving Applications
XIII. Geometric Solids: Surface Area, Volume, and Weights
  A. Cylinders and Prisms
  B. Cones and Pyramids

C. Spheres and Composite Solids
D. Problem Solving Applications

WLD-F6-HO
Use Applied Statistics, Graphs, and Charts For Purpose of Analysis and Problem Solving
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the interpretation of graphs; and,
B. Construct various graphs.

MODULE OUTLINE:

Major Topics

I. The Interpretation of Graphs
  A. The Purpose of Graphs
  B. The Structure of Graphs
  C. Reading Graphs
II. The Construction of Graphs
  A. Bar Graphs
  B. Line Graphs
  C. Broken-Line Graphs
  D. Curve-Line Graphs
  E. Problem Solving Applications

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarised priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and groove welds on T and butt joints on various angles in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDs PM6
072000

2283

2283

Duty G

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-G1-HO
Read Job Method Plan
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Understand job method plan; and,
B. Understand blueprint requirements.

MODULE OUTLINE:

Instruction Topics:
a) Identify symbols and specifications
b) Add, subtract, multiply and divide whole numbers, fractions and decimals
c) Convert Sl (metric) to US (customary) units and vice versa
d) Use calculator to perform basic arithmetic operations
e) Use standard tapes, rules and square
f) Use angle devices, such as inclinometer and protractor
g) Determine weld requirements for specific material
h) Perform measurement and inspection
i) Identify error possibilities within measurement procedures
j) Identify calibration requirements of various precision instruments
k) Alloys and selection of proper welding rod

Student Activities:
a) Review blueprints and/or drawings
b) Perform measurements with precision instruments
c) Find angles with precision instruments
d) Review the benefit of a jig or fixture to increase production and accuracy
e) Identify alloy of parent metal
f) Identify alloy for welding rod to be compatible with parent metal

WLD-G2-HO
Verify and Upgrade Paperwork
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Review work orders, standard procedures, codes and requirements; and,

B. Make changes to paperwork when necessary.

MODULE OUTLINE:

Instruction Topics:

a) Identify symbols and specifications
b) Work orders
c) Production planning
d) Job tickets or packets
e) Obtaining proper materials and alloys

Student Activities (in practical exercise format):

a) Review blueprints and/or drawings
b) Review codes and specifications
c) Follow job order process
d) Ordering and casting of appropriate materials
e) Complete production planning

WLD-G3-HO1

Interpret Drawings and Blueprints

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand information given from a blueprint or drawing;
B. Understand lines, letter descriptions and abbreviations;
C. Understand types of projections; and,
D. Understand section views.

MODULE OUTLINE:

Instruction Topics:

a) Identify symbols and specifications
b) The layouts of blueprints
c) Lines and abbreviations
d) Special instructions for welders

Student Activities:

a) Review blueprints and/or drawings
b) Prepare a drawing for an assigned welding project

WLD-G3-HO2
Interpret Drawings and Blueprints
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Identify organizations that classify metals;
b. Distinguish between types of metal by manufacturing method and/or shape;
c. Identify designation of each digit of a metal classification;
d. Identify carbon and alloy content of a metal using classification system;
e. Identify content of an unknown metal using shop tests; and,
f. Identify conformity of a metal to a specification system.

MODULE OUTLINE:

I. Identify the Organizations That Classify Metals and Discuss the Significance of Each
  A. American Iron and Steel Institute (AISI)
  B. Society of Automotive Engineers (SAE)
  C. American Society for Testing and Materials (ASTM)
  D. American National Standards Institute (ANSI)
  E. Aluminum Association
II. Identify Classifications by Manufacturing Methods or Processes
  A. Hot rolled
  B. Cold rolled
  C. Turned and polished (sometimes referred to as ground and polished)
  D. Castings
  E. Forgings
  F. Galvanized
III. Identify Classifications by Shape
  A. Sheet and plate
  B. Bar stock
  C. Pipe and tubing
  D. Rod and wire
  E. Coil or strip
  F. Structural steel
IV. Discuss the AISI-SAE Numbering Systems for Carbon Steels
  A. Plain carbon steels (AISI-SAE 10xx and 15xx)
  B. Free-cutting steels (AISI-SAE 11xx and 12xx)
V. Discuss the AISI-SAE Classification Systems for Alloy Steels
  A. Manganese steels (AISI-SAE 13xx)
  B. Nickel steels (AISI-SAE 2xxx)
  C. Nickel-chromium steels (AISI-SAE 3xxx)
  D. Molybdenum steels (AISI-SAE 4xxx)
  E. Low chromium steels (AISI-SAE 5xxx)

    - F. Other alloy steels (AISI-SAE 6 lxx, 8xxx, and 9xxx)
- VI. Discuss the AISI-SAE Classification of Stainless Steels
    - A. Chromium-nickel austenitic steels (SAE 30xxx or AISI 20x and 3xx)
    - B. Ferritic chromium steels (SAE 5 lxxx or AISI 4xx and 50x)
    - C. Martensitic chromium steels (SAE 5lxxx or AISI 4xx and 50x)
- VII. Discuss the AISI Classification of Tool Steels
    - A. High speed tool steels (AISI type M and T)
    - B. Hot work tool steels (AISI type H)
    - C. Cold work tool steels (AISI type D, A, and O)
    - D. Shock resisting tool steels (AISI type S)
    - E. Mold steels (AISI type P)
    - F. Special purpose tool steels (AISI type L and F)
    - G. Water hardening tool steels (AISI type W)
- VIII. Discuss the Classification of Nonferrous Alloys
    - A. Aluminum and aluminum alloys (Aluminum Association four digit system)
    - B. Magnesium alloys (SAE type 5x and 5xx)
    - C. Nickel and nickel alloys (by name)
    - D. Titanium and titanium alloys (titanium and chief alloying element)
    - E. Copper and copper alloys (by name and SAE standard number)
- IX. Discuss the Classification of Castings
    - A. Brass and bronze castings (SAE standard number)
    - B. Aluminum casting alloys (Aluminum Association four digit system)
    - C. Cast Iron (ASTM grade)
    - D. Steel Castings (ASTM grade)
- X. Discuss the Unified Numbering System (UNS) for Metals and Alloys
- XI Discuss the Basic Identification of an Unmarked Piece of Steel Using Shop Tests
    - A. Observation
    - B. Magnet test
    - C. Hardness test
    - D. Scratch test
    - E. File test
    - F. Chemical test
    - G. Spark test
- XII. Identify Specification Systems for Metals and Alloys
    - A. American Society for Testing and Materials (ASTM)
    - B. American National Standards Institute (ANSI)
    - C. U.S. Department of Defense (military specifications)
    - D. General Accounting Office (federal specifications)

WLD-G3-HO3
Interpret Drawings and Blueprints
Attachment 3: **MASTER** Handout No. 3

AISI-SAE STANDARD STEELS CLASSIFICATION

AISI-SAE	Type of Steel and Nominal Alloy Content
	Carbon Steels
10xx	Plain Carbon (Max 1% Mn.)
15xx	Plain Carbon (Max 1% - 1.65% Mn.)
11xx	Free Cutting, Resulfurized
12xx	Free Cutting, Resulfurized and Rephosporized
	Manganese Steels
13xx	1.75% Manganese
	Nickel Steels
23xx	3.50% Nickel
25xx	5.00% Nickel
	Nickel-Chromium Steels
31xx	1.25% Nickel; 0.65% and 0.80% Chromium
32xx	1.75% Nickel; 1.07% Chromium
33xx	3.50% Nickel; 1.50% and 1.57% Chromium
34xx	3.00% Nickel; 0.77% Chromium
	Molybdenum Steels
40xx	0.20% and 0.25% Molybdenum
44xx	0.40% and 0.52% Molybdenum
	Chromium-Molybdenum Steels
41xx	0.50% - 0.95% Chromium; 0.12% - 0.30% Molybdenum
	Nickel-Molybdenum Steels
46xx	0.85% and 1.82% Nickel; 0.20% and 0.25% Molybdenum
48xx	3.50% Nickel; 0.25% Molybdenum
	Chromium Steels
50xx	0.27% - 0.65% Chromium
51xx	0.80% - 1.05% Chromium
50xxx	0.50% Chromium; Min. 1.00% Carbon
51xxx	1.02% Chromium; Min. 1.00% Carbon
52xxx	1.45% Chromium; Min. 1.00% Carbon
	Chromium-Vanadium Steels
61xx	0.60% - 0.95% Chromium; 0.10% and 0.15% Vanadium
	Tungsten-Chromium Steels
72xx	1.75% Tungsten; 0.75% Chromium
	Triple Alloy Steels
43xx	1.82% Nickel; 0.50% and 0.80% Chromium; 0.25% Molybdenum
47xx	1.05% Nickel; 0.45% Chromium; 0.20% and 0.35% Molybdenum
8xxx	0.30% - 0.55% Nickel; 0.40% - 0.50% Chromium; 0.12% - 0.35% Molybdenum
92xx	1.40% and 2.00% Silicon; 0.00% and 0.65% Chromium; 0.65% - 0.85% Manganese
93xx	3.25% Nickel; 1.20% Chromium; 0.12% Molybdenum
94xx	0.45% Nickel; 0.40% Chromium; 0.12% Molybdenum
98xx	1.00% Nickel; 0.80% Chromium; 0.25% Molybdenum

AISI	SAE	Stainless Steel
2xx	302xx	Austentic Steels; 16% - 19% Chromium; 1% - 5.5% Nickel
3xx	303xx	Austentic Steels; 16% - 24% Chromium; 6% - 15% Nickel
4xx	514xx	Ferritic or Martensitic Steels; 10.5% - 18% Chromium
5xx	515xx	Ferritic or Martensitic Steels; 4% - 6% Chromium

WLD-G3-HO4
Interpret Drawings and Blueprints
Attachment 4: **MASTER** Handout No. 4

AISI TOOL STEELS CLASSIFICATION

CATEGORY DESIGNATION	AISI	GROUP DESIGNATION
High Speed Tool Steels	M T	Molybdenum Types Tungsten Types
Hot Work Tool Steels	H1 - H19 H20 - H39 H40 - H59	Chromium Types Tungsten Types Molybdenum Types
Cold Work Tool Steels	D A O	High Carbon, High Chromium Types Medium Alloy, Air Hardening Types Oil Hardening Types
Shock Resisting Tool Steels	S	------
Mold Steels	P	------
Special Purpose Tool Steels	L F	Low Alloy Types Carbon Tungsten Types
Water Hardening Tool Steels	W	------

UNIFIED NUMBERING SYSTEM (UNS) FOR METALS & ALLOYS

UNS SERIES	METAL
Nonferrous Metals and Alloys	
A00001 to A99999	Aluminum and Aluminum Alloys
C00001 to C99999	Copper and Copper Alloys
E00001 to E99999	Rare Earth and Rare Earth-Like Metals and Alloys
L00001 to L99999	Low Melting Metals and Alloys
M00001 to M99999	Miscellaneous Nonferrous Metals and Alloys
P00001 to P99999	Precious Metals and Alloys
R00001 to R99999	Reactive and Refractory Metals and Alloys
Z00001 to Z99999	Zinc and Zinc Alloys
Ferrous Metals and Alloys	
D00001 to D99999	Specified Mechanical Property Steels
F00001 to F99999	Cast Irons
G00001 to G99999	AISI and SAE Carbon and Alloy Steels (Except Tool Steels)
H00001 to H99999	AISI H-Steels
J00001 to J99999	Cast Steels (Except Tool Steels)
K00001 to K99999	Miscellaneous Steels and Ferrous Alloys
S00001 to S99999	Heat and Corrosion Resistant (Stainless Steels)
T00001 to T99999	Tool Steels

WLD-G3-HO5
Interpret Drawings and Blueprints
Attachment 5: **MASTER** Handout No. 5

EXAMPLE OF A SPECIFICATION

HOT ROLLED CARBON STEEL BARS							
	Tolerance		Out of		Tolerance		Out of
Size	Plus	Minus	Section	Size	Plus	Minus	Section
Rounds, Squares and Round-Cornered Squares							
To 5/16	.005	.005	.008	Over 1-1/2 to 2	1/64	1/64	.023
Over 5/16 to 7/16	.006	.006	.009	Over 2 to 2-1/2	1/32	0	.023
Over 7/16 to 5/8	.007	.007	.010	Over 2-1/2 to 3-1/2	3/64	0	.035
Over 5/8 to 7/8	.008	.008	.012	Over 3-1/2 to 4-1/2	1/16	0	.046
Over 7/8 to 1	.009	.009	.013	Over 4-1/2 to 5-1/2	5/64	0	.058
Over 1 to 1-1/8	.010	.010	.015	Over 5-1/2 to 6-1/2	1/8	0	.070
Over 1/18 to 1-1/4	.011	.011	.016	Over 6-1/2 to 8-1/4	5/32	0	.085
Over 1-1/4 to 1-3/8	.012	.012	.018	Over 8-1/4 to 9-1/2	3/16	0	.100
Over 1-3/8 to 1-1/2	.014	.014	.021	Over 9-1/2 to 10	1/4	0	.120
Hexagons							
To 1/2	.007	.007	.011	Over 1-1/2 to 2	1/32	1/64	1/32
Over 1/2 to 1	.010	.120	.015	Over 2 to 2-1/2	3/64	1/64	3/64
Over 1 to 1-1/2	.021	.130	.025	Over 2-1/2 to 3-1/2	1/16	1/64	1/16
COLD FINISHED CARBON STEELS							
	Max. % Carbon				Max. % Carbon		
Size	Up to .28	Over .28 to .55	Over .55	Size	Up to .28	Over .28 to .55	Over .55
	Minus Tolerance				Minus Tolerance		
Cold Drawn Rounds				Cold Drawn Flats			
To 1-1/2	.002	.003	.005	To 3/4	.003	.004	.008
Over 1-1/2 to 2-1/2	.003	.004	.006	Over 3/4 to 1-1/2	.004	.005	.010
Over 2-1/2 to 4	.004	.005	.007	Over 1-1/2 to 3	.005	.006	.012
Over 4 to 6	.005	.006	.008	Over 3 to 4	.006	.008	.016
				Over 4 to 6	.008	.010	.020
				Over 6	.013	.015	-----
Cold Drawn Hexagons				Cold Drawn Squares			
To 3/4	.002	.003	.006	To 3/4	.002	.004	.007
Over 3/4 to 1-1/2	.003	.004	.007	Over 3/4 to 1-1/2	.003	.005	.008
Over 1-1/2 to 2-1/2	.004	.005	.008	Over 1-1/2 to 2-1/2	.004	.006	.009
Over 2-1/2 to 3-1/8	.005	.006	.009	Over 2-1/2 to 4	.005	.008	.011
Turned and Polished Rounds							
To 1-1/2	.002	.003	.005	Over 4 to 6	.005	.006	.008
Over 1-1/2 to 2-1/2	.003	.004	.006	Over 6 to 8	.006	.007	.009
Over 2-1/2 to 4	.004	.005	.007	Over 8 to 9	.007	.008	.010

WLD-G3-LA
Interpret Drawings and Blueprints
Attachment 6: **MASTER** Laboratory Aid

List of Materials for Shop Tests and Illustration

1. **Observation Test**
   Sample of round bars with various surface finishes (cold finished, hot rolled, ground and polished)

2. **Magnet Test**
   Sample of carbon steel, ferritic or martensitic stainless steel, austenitic stainless steel, aluminum, and nickel steel

3. **Hardness Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

4. **Scratch Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

5. **File Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

6. **Chemical Test**
   Sample of carbon steel, type 302 or 304 stainless steel, type 316 or 317 stainless steel

7. **Spark Test**
   Sample of low carbon steel, high carbon steel, cast iron, high speed steel, tool steel, and manganese steel

8. **Observation Test**
   Samples of bar stock (round and square), hot rolled sheet, cold finished coil strip, galvanized sheet, small diameter pipe, small diameter tubing, small gauge wire, hot rolled rod, and cold finished rod

WLD-G3-LE
Interpret Drawings and Blueprints
Attachment 7: **MASTER** Laboratory Exercise

---

1. The instructor will:
    a. Demonstrate use of drafting machine;
    b. Demonstrate use of drafting instruments;
    c. Demonstrate drafting techniques to create basic geometric elements;
    d. Demonstrate sketching techniques, including:
        (1) Isometric sketching;
        (2) Oblique sketching; and,
        (3) One-point and two-point perspective sketching.

2. The student will:
    a. Demonstrate use of drafting machine;
    b. Demonstrate use of drafting instruments;
    c. Demonstrate drafting techniques to create basic geometric elements, which include:
        (1) Bisecting a line or a circular arc;
        (2) Bisecting an angle and to transfer an angle;
        (3) Constructing a line parallel to a given line at a given distance;
        (4) Dividing a line into equal or proportional parts;
        (5) Constructing a triangle with the length of the sides given;
        (6) Inscribing a circle in a triangle;
        (7) Constructing a right triangle with hypotenuse and one side given;
        (8) Constructing a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line;
        (9) Constructing a square with a side given;
        (10) Inscribing a regular pentagon in a given circle;
        (11) Inscribing and circumscribing a hexagon on a given circle;
        (12) Inscribing an octagon in a given square;
        (13) Constructing a circle through three given points not in a straight line;
        (14) Constructing a circle of a given size tangent to a given line and passing through a given point;
        (15) Constructing a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line;
        (16) Constructing a circle of a given size tangent to a given circle and passing through a given point;
        (17) Constructing an arc of a given size tangent to two given intersecting lines at acute or obtuse angles;
        (18) Constructing a given size circle tangent to two given circles;
        (19) Constructing an ellipse using the concentric circle method with major and minor diameters given;

(20) Construct an approximate ellipse with major and minor diameters given;

d. Demonstrate sketching techniques, including:
   - (1) Isometric sketching;
   - (2) Oblique sketching; and,
   - (3) One-point and two-point perspective sketching.

3. The instructor will grade the student's performance on the student's ability to:
   - a. Demonstrate use of drafting machine;
   - b. Demonstrate use of drafting instruments;
   - c. Demonstrate drafting techniques to create basic geometric elements, which include:
     - (1) Bisecting a line or a circular arc;
     - (2) Bisecting an angle and to transfer an angle;
     - (3) Constructing a line parallel to a given line at a given distance;
     - (4) Dividing a line into equal or proportional parts;
     - (5) Constructing a triangle with the length of the sides given;
     - (6) Inscribing a circle in a triangle;
     - (7) Constructing a right triangle with hypotenuse and one side given;
     - (8) Constructing a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line;
     - (9) Constructing a square with a side given;
     - (10) Inscribing a regular pentagon in a given circle;
     - (11) Inscribing and circumscribing a hexagon on a given circle;
     - (12) Inscribing an octagon in a given square;
     - (13) Constructing a circle through three given points not in a straight line;
     - (14) Constructing a circle of a given size tangent to a given line and passing through a given point;
     - (15) Constructing a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line;
     - (16) Constructing a circle of a given size tangent to a given circle and passing through a given point;
     - (17) Constructing an arc of a given size tangent to two given intersecting lines at acute or obtuse angles;
     - (18) Constructing a given size circle tangent to two given circles;
     - (19) Constructing an ellipse using the concentric circle method with major and minor diameters given;
     - (20) Construct an approximate ellipse with major and minor diameters given.
   - d. Demonstrate sketching techniques, including:
     - (1) Isometric sketching;
     - (2) Oblique sketching; and,
     - (3) One-point and two-point perspective sketching.

WLD-G3-LW

Interpret Drawings and Blueprints

Attachment 8: **MASTER** Laboratory Worksheet

I. Identify the following:

a. AISI ______________________________

b. SAE ______________________________

c. ASTM ______________________________

d. ANSI ______________________________

e. UNS ______________________________

II. Complete the following charts:

A. Standard Steels and Alloy Steels

	AISI-SAE	APP % CARBON	MAJOR ALLOYING ELEMENTS
Ex.	1020	.20	Only Carbon
Ex.	6118	.18	Chromium & Vanadium
Ex.	4340	.40	Nickel, Chromium, Molybdenum
1.	1040		
2.	1095		
3.	1212		
4.	1340		
5.	2340		
6.	2512		
7.	3140		
8.	3310		
9.	4024		
10.	4140		
11.	4320		
12.	4620		
13.	5135		
14.	52100		
15.	6150		

B. AISI-SAE-UNS Classification System

	AISI-SAE	UNS	TYPE METAL OR STEEL
Ex.	1212	G12120	Free Cutting Carbon Steel
Ex.	48xx	G48xx0	Nickel-Molybdenum Steel
Ex.	A6	T30106	Air Harden Cold Work Tool Steel
1.	1527		
2.	1151		
3.		G10290	
4.		G41xx0	
5.		G61500	
6.			Tungsten-Chromium Steels
7.			Austenitic Stainless Steels
8.			Nickel Steels
9.	H21	T20821	
10.		T12002	Tungsten High Speed Tool Steels
11.	Sx	T4190x	
12.	D2	T30402	
13.		T41906	Shock Resisting Tool Steels
14.	-----	Axxxxx	
15.			Copper and Copper Alloy

III. Answer the following questions:

A. What is the out-of-round tolerance for 2-1/2" diameter hot rolled bar?

B. What is the size tolerance for 1-3/4" cold finished hexagon bar made from 1045?

C. If the only requirements given you were 1" 1018 square bar with a size tolerance of -.006, would you choose hot rolled (much cheaper) or cold finished stock?

IV. Record the results of your shop test below.

Item No.	Test Used	Kind of Metal
1.		
2.		
3.		
4.		
5.		

WLD-G4-HO1
Read Welding Specifications and Procedures
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand specifications and procedures; and,
B. Understand tolerances, defects, and discontinuities.

MODULE OUTLINE:

Instruction Topics:

a) Identify symbols and specifications
b) Accepted procedures for types of welding operations (sources)
c) Dimensioning tolerancing
d) Weld defects and discontinuities
e) Weld quality standards

Student Activities:

a) View blueprints and/or drawings
b) See examples of weld defects and discontinuities

WLD-G4-HO2
Read Welding Specifications and Procedures
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Identify organizations that classify metals;
b. Distinguish between types of metal by manufacturing method and/or shape;
c. Identify designation of each digit of a metal classification;
d. Identify carbon and alloy content of a metal using classification system;
e. Identify content of an unknown metal using shop tests; and,
f. Identify conformity of a metal to a specification system.

MODULE OUTLINE:

I. Identify the Organizations That Classify Metals and Discuss the Significance of Each
    A. American Iron and Steel Institute (AISI)
    B. Society of Automotive Engineers (SAE)
    C. American Society for Testing and Materials (ASTM)
    D. American National Standards Institute (ANSI)
    E. Aluminum Association
II. Identify Classifications by Manufacturing Methods or Processes
    A. Hot rolled
    B. Cold rolled
    C. Turned and polished (sometimes referred to as ground and polished)
    D. Castings
    E. Forgings
    F. Galvanized
III. Identify Classifications by Shape
    A. Sheet and plate
    B. Bar stock
    C. Pipe and tubing
    D. Rod and wire
    E. Coil or strip
    F. Structural steel
IV. Discuss the AISI-SAE Numbering Systems for Carbon Steels
    A. Plain carbon steels (AISI-SAE 10xx and 15xx)
    B. Free-cutting steels (AISI-SAE 11xx and 12xx)
V. Discuss the AISI-SAE Classification Systems for Alloy Steels
    A. Manganese steels (AISI-SAE 13xx)
    B. Nickel steels (AISI-SAE 2xxx)
    C. Nickel-chromium steels (AISI-SAE 3xxx)
    D. Molybdenum steels (AISI-SAE 4xxx)
    E. Low chromium steels (AISI-SAE 5xxx)
    F. Other alloy steels (AISI-SAE 6 lxx, 8xxx, and 9xxx)
VI. Discuss the AISI-SAE Classification of Stainless Steels

  - A. Chromium-nickel austenitic steels (SAE 30xxx or AISI 20x and 3xx)
  - B. Ferritic chromium steels (SAE 5 lxxx or AISI 4xx and 50x)
  - C. Martensitic chromium steels (SAE 5lxxx or AISI 4xx and 50x)
- VII. Discuss the AISI Classification of Tool Steels
  - A. High speed tool steels (AISI type M and T)
  - B. Hot work tool steels (AISI type H)
  - C. Cold work tool steels (AISI type D, A, and O)
  - D. Shock resisting tool steels (AISI type S)
  - E. Mold steels (AISI type P)
  - F. Special purpose tool steels (AISI type L and F)
  - G. Water hardening tool steels (AISI type W)
- VIII. Discuss the Classification of Nonferrous Alloys
  - A. Aluminum and aluminum alloys (Aluminum Association four digit system)
  - B. Magnesium alloys (SAE type 5x and 5xx)
  - C. Nickel and nickel alloys (by name)
  - D. Titanium and titanium alloys (titanium and chief alloying element)
  - E. Copper and copper alloys (by name and SAE standard number)
- IX. Discuss the Classification of Castings
  - A. Brass and bronze castings (SAE standard number)
  - B. Aluminum casting alloys (Aluminum Association four digit system)
  - C. Cast Iron (ASTM grade)
  - D. Steel Castings (ASTM grade)
- X. Discuss the Unified Numbering System (UNS) for Metals and Alloys
- XI. Discuss the Basic Identification of an Unmarked Piece of Steel Using Shop Tests
  - A. Observation
  - B. Magnet test
  - C. Hardness test
  - D. Scratch test
  - E. File test
  - F. Chemical test
  - G. Spark test
- XII. Identify Specification Systems for Metals and Alloys
  - A. American Society for Testing and Materials (ASTM)
  - B. American National Standards Institute (ANSI)
  - C. U.S. Department of Defense (military specifications)
  - D. General Accounting Office (federal specifications)

WLD-G4-HO3
Read Welding Specifications and Procedures
Attachment 3: MASTER Handout No. 3

AISI-SAE STANDARD STEELS CLASSIFICATION

AISI-SAE	Type of Steel and Nominal Alloy Content
	Carbon Steels
10xx	Plain Carbon (Max 1% Mn.)
15xx	Plain Carbon (Max 1% - 1.65% Mn.)
11xx	Free Cutting, Resulfurized
12xx	Free Cutting, Resulfurized and Rephosporized
	Manganese Steels
13xx	1.75% Manganese
	Nickel Steels
23xx	3.50% Nickel
25xx	5.00% Nickel
	Nickel-Chromium Steels
31xx	1.25% Nickel; 0.65% and 0.80% Chromium
32xx	1.75% Nickel; 1.07% Chromium
33xx	3.50% Nickel; 1.50% and 1.57% Chromium
34xx	3.00% Nickel; 0.77% Chromium
	Molybdenum Steels
40xx	0.20% and 0.25% Molybdenum
44xx	0.40% and 0.52% Molybdenum
	Chromium-Molybdenum Steels
41xx	0.50% - 0.95% Chromium; 0.12% - 0.30% Molybdenum
	Nickel-Molybdenum Steels
46xx	0.85% and 1.82% Nickel; 0.20% and 0.25% Molybdenum
48xx	3.50% Nickel; 0.25% Molybdenum
	Chromium Steels
50xx	0.27% - 0.65% Chromium
51xx	0.80% - 1.05% Chromium
50xxx	0.50% Chromium; Min. 1.00% Carbon
51xxx	1.02% Chromium; Min. 1.00% Carbon
52xxx	1.45% Chromium; Min. 1.00% Carbon
	Chromium-Vanadium Steels
61xx	0.60% - 0.95% Chromium; 0.10% and 0.15% Vanadium
	Tungsten-Chromium Steels
72xx	1.75% Tungsten; 0.75% Chromium
	Triple Alloy Steels
43xx	1.82% Nickel; 0.50% and 0.80% Chromium; 0.25% Molybdenum
47xx	1.05% Nickel; 0.45% Chromium; 0.20% and 0.35% Molybdenum
8xxx	0.30% - 0.55% Nickel; 0.40% - 0.50% Chromium; 0.12% - 0.35% Molybdenum
92xx	1.40% and 2.00% Silicon; 0.00% and 0.65% Chromium; 0.65% - 0.85% Manganese
93xx	3.25% Nickel; 1.20% Chromium; 0.12% Molybdenum
94xx	0.45% Nickel; 0.40% Chromium; 0.12% Molybdenum
98xx	1.00% Nickel; 0.80% Chromium; 0.25% Molybdenum

AISI	SAE	Stainless Steel
2xx	302xx	Austentic Steels; 16% - 19% Chromium; 1% - 5.5% Nickel
3xx	303xx	Austentic Steels; 16% - 24% Chromium; 6% - 15% Nickel
4xx	514xx	Ferritic or Martensitic Steels; 10.5% - 18% Chromium
5xx	515xx	Ferritic or Martensitic Steels; 4% - 6% Chromium

WLD-G4-HO4
Read Welding Specifications and Procedures
Attachment 4: **MASTER** Handout No. 4

AISI TOOL STEELS CLASSIFICATION

CATEGORY DESIGNATION	AISI	GROUP DESIGNATION
High Speed Tool Steels	M	Molybdenum Types
	T	Tungsten Types
Hot Work Tool Steels	H1 - H19	Chromium Types
	H20 - H39	Tungsten Types
	H40 - H59	Molybdenum Types
Cold Work Tool Steels	D	High Carbon, High Chromium Types
	A	Medium Alloy, Air Hardening Types
	O	Oil Hardening Types
Shock Resisting Tool Steels	S	------
Mold Steels	P	------
Special Purpose Tool Steels	L	Low Alloy Types
	F	Carbon Tungsten Types
Water Hardening Tool Steels	W	------

UNIFIED NUMBERING SYSTEM (UNS) FOR METALS & ALLOYS

UNS SERIES	METAL
Nonferrous Metals and Alloys	
A00001 to A99999	Aluminum and Aluminum Alloys
C00001 to C99999	Copper and Copper Alloys
E00001 to E99999	Rare Earth and Rare Earth-Like Metals and Alloys
L00001 to L99999	Low Melting Metals and Alloys
M00001 to M99999	Miscellaneous Nonferrous Metals and Alloys
P00001 to P99999	Precious Metals and Alloys
R00001 to R99999	Reactive and Refractory Metals and Alloys
Z00001 to Z99999	Zinc and Zinc Alloys
Ferrous Metals and Alloys	
D00001 to D99999	Specified Mechanical Property Steels
F00001 to F99999	Cast Irons
G00001 to G99999	AISI and SAE Carbon and Alloy Steels (Except Tool Steels)
H00001 to H99999	AISI H-Steels
J00001 to J99999	Cast Steels (Except Tool Steels)
K00001 to K99999	Miscellaneous Steels and Ferrous Alloys
S00001 to S99999	Heat and Corrosion Resistant (Stainless Steels)
T00001 to T99999	Tool Steels

WLD-G4-HO5

Read Welding Specifications and Procedures

Attachment 5: **MASTER** Handout No. 5

EXAMPLE OF A SPECIFICATION

HOT ROLLED CARBON STEEL BARS							
Size	Tolerance		Out of Section	Size	Tolerance		Out of Section
	Plus	Minus			Plus	Minus	
Rounds, Squares and Round-Cornered Squares							
To 5/16	.005	.005	.008	Over 1-1/2 to 2	1/64	1/64	.023
Over 5/16 to 7/16	.006	.006	.009	Over 2 to 2-1/2	1/32	0	.023
Over 7/16 to 5/8	.007	.007	.010	Over 2-1/2 to 3-1/2	3/64	0	.035
Over 5/8 to 7/8	.008	.008	.012	Over 3-1/2 to 4-1/2	1/16	0	.046
Over 7/8 to 1	.009	.009	.013	Over 4-1/2 to 5-1/2	5/64	0	.058
Over 1 to 1-1/8	.010	.010	.015	Over 5-1/2 to 6-1/2	1/8	0	.070
Over 1/18 to 1-1/4	.011	.011	.016	Over 6-1/2 to 8-1/4	5/32	0	.085
Over 1-1/4 to 1-3/8	.012	.012	.018	Over 8-1/4 to 9-1/2	3/16	0	.100
Over 1-3/8 to 1-1/2	.014	.014	.021	Over 9-1/2 to 10	¼	0	.120
Hexagons							
To 1/2	.007	.007	.011	Over 1-1/2 to 2	1/32	1/64	1/32
Over 1/2 to 1	.010	.120	.015	Over 2 to 2-1/2	3/64	1/64	3/64
Over 1 to 1-1/2	.021	.130	.025	Over 2-1/2 to 3-1/2	1/16	1/64	1/16
COLD FINISHED CARBON STEELS							
Size	Max. % Carbon			Size	Max. % Carbon		
	Up to .28	Over .28 to .55	Over .55		Up to .28	Over .28 to .55	Over .55
	Minus Tolerance				Minus Tolerance		
Cold Drawn Rounds				Cold Drawn Flats			
To 1-1/2	.002	.003	.005	To 3/4	.003	.004	.008
Over 1-1/2 to 2-1/2	.003	.004	.006	Over 3/4 to 1-1/2	.004	.005	.010
Over 2-1/2 to 4	.004	.005	.007	Over 1-1/2 to 3	.005	.006	.012
Over 4 to 6	.005	.006	.008	Over 3 to 4	.006	.008	.016
				Over 4 to 6	.008	.010	.020
				Over 6	.013	.015	-----
Cold Drawn Hexagons				Cold Drawn Squares			
To 3/4	.002	.003	.006	To 3/4	.002	.004	.007
Over 3/4 to 1-1/2	.003	.004	.007	Over 3/4 to 1-1/2	.003	.005	.008
Over 1-1/2 to 2-1/2	.004	.005	.008	Over 1-1/2 to 2-1/2	.004	.006	.009
Over 2-1/2 to 3-1/8	.005	.006	.009	Over 2-1/2 to 4	.005	.008	.011
Turned and Polished Rounds							
To 1-1/2	.002	.003	.005	Over 4 to 6	.005	.006	.008
Over 1-1/2 to 2-1/2	.003	.004	.006	Over 6 to 8	.006	.007	.009
Over 2-1/2 to 4	.004	.005	.007	Over 8 to 9	.007	.008	.010

WLD-G4-HO6

Read Welding Specifications and Procedures

Attachment 6: **MASTER** Handout No. 6

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Discuss classification system for metals; and,
- b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals.

MODULE OUTLINE:

- I. Discuss the Physical Properties of Metal
  - A. Brittleness - the property of a metal which permits no permanent distortion before breaking
  - B. Ductility - the ability of the metal to be permanently deformed without breaking
  - C. Elasticity - the ability of a metal to return to its original shape after any force acting upon it has been removed
  - D. Hardness - the resistance to forcible penetration
  - E. Malleability - the property of a metal which permits it to be hammered or rolled into other sizes and shapes
  - F. Tensile strength - the maximum amount of pull that a material will withstand before breaking
  - G. Toughness - the property of a metal to withstand shock or impact
- II. Discuss the Classification System for Steel
  - A. Carbon steels
    - 1. Low carbon steel - contains from 0.02 to 0.20 percent of carbon
    - 2. Medium carbon steel - contains from 0.30 to 0.60 percent of carbon
    - 3. High carbon steel (tool steel) - contains over 0.60 percent of carbon
  - B. Alloy steels - alloying elements allow steels to possess special characteristics
    Discuss Table 1.1 "Effects of Alloying Elements on Steel"
    Discuss Table 1.2 "SAE-ANSI Numerical Designation of Alloy Steels"
- III. Describe General Characteristics For:
  - A. Carbon Steels
  - B. Tool Steels
  - C. Stainless Steels
  - D. Structural Steels
  - E. Cast Irons
  - F. Non-Ferrous Metals
    - 1. Aluminum and Its Alloys
    - 2. Copper and Its Alloys
    - 3. Nickel Alloys
    - 4. Precious Metals
    - 5. Others

WLD-G4-HO7
Read Welding Specifications and Procedures
Attachment 7: **MASTER** Handout No. 7

TABLES FOR PROPERTIES OF METALS
TABLE 1.1

THE EFFECT OF ALLOYING ELEMENTS ON STEEL

Effect	Elements											
	carbon	chromium	cobalt	lead	manganese	Molybdenum	nickel	phosphorus	silicon	sulfur	tungsten	vanadium
Increases tensile strength	x	x			x	x	x					
Increases hardness	x	x										
Increases wear resistance	x	x			x		x				x	
Increases hardenability	x	x			x	x	x					x
Increases ductility					x							
Increases elastic limit		x				x						
Increases rust resistance		x					x					
Increases abrasion resistance		x			x							
Increases toughness		x				x	x					x
Increases shock resistance		x					x					x
Increases fatigue resistance												x
Decreases ductility	x	x										
Decreases toughness			x									
Raises critical temperature		x	x								x	
Lowers critical temperature					x		x					
Causes hot shortness										x		
Causes cold shortness								X				
Imparts red hardness			x			x					x	
Imparts fine grain structure					x							x
Reduces deformation					x		x					
Acts as deoxidizer					x				x			
Acts as desulphurizer					x							
Imparts oil hardening properties		x			x	x	x					
Imparts air hardening properties					x	x						
Eliminates blow holes								X				
Creates soundness in casting									x			
Facilitates rolling and forging					x				x			
Improves machinability				x						x		

WLD-G4-HO8

Read Welding Specifications and Procedures

Attachment 8: **MASTER** Handout No. 8

TABLE 1.2

SAE-AISI NUMERICAL DESIGNATION OF ALLOY STEELS
(x represents percent of carbon in hundredths)

Carbon Steels	
Plain carbon	10xx
Free-cutting, resulfurized	11xx
Manganese Steels	13xx
Nickel Steels	
.50% nickel	20xx
1.50% nickel	21xx
3.50% nickel	23xx
5.00% nickel	25xx
Nickel-Chromium Steels	
1.25% nickel, .65% chromium	31xx
1.75% nickel, 1.00% chromium	32xx
3.50% nickel, 1.57% chromium	33xx
3.00% nickel, .80% chromium	34xx
Corrosion and heat-resisting steels	303xx
Molybdenum Steels	
Chromium	41xx
Chromium-nickel	43xx
Nickel	46xx and 48xx
Chromium Steels	
Low-chromium	50xx
Medium-chromium	511xx
High-chromium	521xx
Chromium-Vanadium Steels	6xxx
Tungsten Steels	7xxx and 7xxxx
Triple-Alloy Steels	8xxx
Silicon-Manganese Steels	9xxx
Leaded Steels	11Lxx (example)

WLD-G4-HO9
Read Welding Specifications and Procedures
Attachment 9: **MASTER** Handout No. 9

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Briefly describe and list the advantages and disadvantages for each of the following: casting processes, hot working processes, and cold working processes;
b. Discuss service requirements (strength, hardness, etc.);
c. Discuss fastening processes (fasteners, welding, bonding, etc.); and,
d. Discuss corrosion resistance methods.

MODULE OUTLINE:

I. Describe Casting Processes
  A. Discuss the following casting processes: sand, evaporative, shell molding, permanent mold, centrifugal, investment, and die casting
  B. Discuss pattern and mold design factors for each of the above casting processes
  C. List the advantages and disadvantages of the casting processes
II. Describe Hot Working Processes
  A. Discuss the following hot working processes: rolling, strand casting, forging, drawing, extrusion, spinning, and roll forming
  B. List the advantages and disadvantages of the hot working processes
III. Describe Cold Working Processes
  A. Discuss the following cold working processes: rolling, blanking, pressing, drawing, extruding, wire and bar drawing, bending, shearing, and roll forming
  B. List the advantages and disadvantages of the cold working process
IV. Evaluate Alternative Manufacturing Processes
  A. Discuss the powder metallurgy process (PM)
  B. Discuss the following nontraditional machining processes: EDM, laser machining, ultrasonic machining, hydrojet machining, electron beam machining, and plasma beam machining

WLD-G4-LA
Read Welding Specifications and Procedures
Attachment 10: **MASTER** Laboratory Aid

List of Materials for Shop Tests and Illustration

1. **Observation Test**
   Sample of round bars with various surface finishes (cold finished, hot rolled, ground and polished)

2. **Magnet Test**
   Sample of carbon steel, ferritic or martensitic stainless steel, austenitic stainless steel, aluminum, and nickel steel

3. **Hardness Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

4. **Scratch Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

5. **File Test**
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

6. **Chemical Test**
   Sample of carbon steel, type 302 or 304 stainless steel, type 316 or 317 stainless steel

7. **Spark Test**
   Sample of low carbon steel, high carbon steel, cast iron, high speed steel, tool steel, and manganese steel

8. **Observation Test**
   Samples of bar stock (round and square), hot rolled sheet, cold finished coil strip, galvanized sheet, small diameter pipe, small diameter tubing, small gauge wire, hot rolled rod, and cold finished rod

WLD-G4-LW
Read Welding Specifications and Procedures
Attachment 11: **MASTER** Laboratory Worksheet

I. Identify the following:

- a. AISI ______________________________
- b. SAE ______________________________
- c. ASTM ______________________________
- d. ANSI ______________________________
- e. UNS ______________________________

II. Complete the following charts:

A. Standard Steels and Alloy Steels

	AISI-SAE	APP % CARBON	MAJOR ALLOYING ELEMENTS
Ex.	1020	.20	Only Carbon
Ex.	6118	.18	Chromium & Vanadium
Ex.	4340	.40	Nickel, Chromium, Molybdenum
1.	1040		
2.	1095		
3.	1212		
4.	1340		
5.	2340		
6.	2512		
7.	3140		
8.	3310		
9.	4024		
10.	4140		
11.	4320		
12.	4620		
13.	5135		
14.	52100		
15.	6150		

B. AISI-SAE-UNS Classification System

	AISI-SAE	UNS	TYPE METAL OR STEEL
Ex.	1212	G12120	Free Cutting Carbon Steel
Ex.	48xx	G48xx0	Nickel-Molybdenum Steel
Ex.	A6	T30106	Air Harden Cold Work Tool Steel
1.	1527		
2.	1151		
3.		G10290	
4.		G41xx0	
5.		G61500	
6.			Tungsten-Chromium Steels
7.			Austenitic Stainless Steels
8.			Nickel Steels
9.	H21	T20821	
10.		T12002	Tungsten High Speed Tool Steels
11.	Sx	T4190x	
12.	D2	T30402	
13.		T41906	Shock Resisting Tool Steels
14.	-----	Axxxxx	
15.			Copper and Copper Alloy

III. Answer the following questions:

A. What is the out-of-round tolerance for 2-1/2" diameter hot rolled bar?

B. What is the size tolerance for 1-3/4" cold finished hexagon bar made from 1045?

C. If the only requirements given you were 1" 1018 square bar with a size tolerance of -.006, would you choose hot rolled (much cheaper) or cold finished stock?

IV. Record the results of your shop test below.

Item No.	Test Used	Kind of Metal
1.		
2.		
3.		
4.		
5.		

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Interconvert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read [illegible] method plan	G-2 Verify and upgrade paper work	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

[illegible]

23:0

Duty H

23:1

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post-finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required; understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the all position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-H1-HO1
Understand Parts of Blueprint
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Introduce related terms and definitions;
B. Define proper terms and definitions;
C. Define lines, dimensions and notes;
D. Perform metric conversions;
E. Discuss orthographic views;
F. Interpret blueprint information; and,
G. Depict proper layout.

PRESENTATION OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup
B. Demonstrate how to use the reference on a blueprint
C. Lines, dimensions and notes
D. Demonstrate how to scribe a line using a square and a protractor
E. Illustrate how to use the print to find angles
F. Define the following: precision, reliability and accuracy
G. Define tolerance and how to find it on a blueprint
H. Metrics for welders
I. Demonstrate semi-precision measurements techniques
J. Discuss the importance of the tolerance
K. Discriminate between accepted measurement procedures and improper measurement procedures
L. Explain calibration requirements of various precision instruments
M. Illustrate where to locate measurements

Student Activities:

A. Frame and scribe parts for welding and cutting
B. Use measuring techniques on parts
C. Produce a drawing which includes weld symbols

WLD-H1-HO2
Understand Parts of Blueprint
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
  A. General notes
  B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
  A. General notes applied
    1. Title strip/title block
    2. Parts list/bill of material
  B. Interpret general notes
    1. Including material
    2. General tolerances
    3. Heat treatment
    4. Pattern information
    5. Processes of manufacture
    6. Requirements of the product
  C. Interpret specific notes
    1. Apply to specific operations
    2. Apply to specific processes of manufacture
    3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
  A. Identify organizations that determine dimension standards
    1. American National Standards Institutes (ANSI)
    2. International Standards Organization (ISO)
  B. Determine dimensions on a drawing
    1. Size dimensions
    2. Location dimensions
  C. Applying dimensions on a drawing
    1. Scale of drawing
    2. Techniques of dimensioning
    3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
  - 1. General tolerances
  - 2. Limit dimensioning
  - 3. Plus and minus dimensioning
    - a. Unilateral system
    - b. Bilateral system
  - 4. Single-limit dimensioning
  - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
  - 1. Clearance fit
  - 2. Interference fit
  - 3. Transition fit
  - 4. Line fit
- B. Limits and fits for cylindrical parts
  - 1. Running or sliding clearance fits
  - 2. Locational clearance fits
  - 3. Transition clearance interference fits
  - 4. Locational interference fits
  - 5. Force or shrink fits

WLD-H1-HO3
Understand Parts of Blueprint
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry
III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols
    1. Straightness

        - 2. Flatness
        - 3. Circularity
        - 4. Cylindrical
- IV. Explain and Use Profile Tolerances
    - A. Explain profile tolerance
    - B. Identify and use profile tolerance symbols
        - 1. Profile of a line
        - 2. Profile of a surface
        - 3. Profile of an arc
        - 4. Profile of irregular curves
        - 5. Profile of coplanar surfaces
- V. Explain and Use Tolerances of Orientation
    - A. Explain orientation tolerances
    - B. Identify and use orientation tolerance symbols
        - 1. Parallelism
        - 2. Perpendicularity
        - 3. Angularity
- VI. Explain and Use Runout Tolerances
    - A. Explain runouts
        - 1. Circular
        - 2. Total
    - B. Identify and use runout tolerances symbols
        - 1. Circular
        - 2. Total
- VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    - A. Maximum Material Condition (MMC)
    - B. Regardless of Feature Size (RFS)
    - C. Least Material Condition (LMC)
    - D. Datum feature symbol
    - E. Datum reference frame concept
        - 1. Primary datum plane
        - 2. Secondary datum plane
        - 3. Tertiary datum plane
    - F. Datum target symbol
        - 1. Target point
        - 2. Target line
        - 3. Target area
- VIII. Explain and Use the Feature Control Frame
    - A. Explain feature control frame
    - B. Explain the compartments of a feature control frame
        - 1. Geometric characteristic symbol
        - 2. Geometric tolerance
        - 3. Zone descriptor
        - 4. Material condition symbol
        - 5. Primary datum reference

        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WLD-H2-HO1
Describe Alphabet of Lines
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify orthographic views;
B. Understand standard drawing lines and symbols; and,
C. Interpret blueprint information.

MODULE OUTLINE:

Instructional Topics:

A. Present basic lines and views
B. Locations and alignment of views
C. Review print notes, dimensions and symbols
    1) Interpret AWS standard welding symbols
    2) List essential components found in general notes on drawing
    3) Determine acceptable tolerances for drawing
    4) Determine code requirements, process and procedure requirements required by drawing
    5) Interpret multi-view drawings
    6) Work from drawings
D. Identify basic layouts of drawings
E. Interpret drawing lines, views, and symbols
F. Interpret welding symbols
G. Convert metric to English
H. Understand print specifications
I. List assembly procedure per print
J. Understand various types of welding prints
K. Visualize final weldment from print
L. List flaws and mistakes on drawings
M. Interpret AWS standard welding symbols

Student Activities:

A. Use basic sketching techniques
B. Frame and scribe parts for welding and cutting
C. Use measuring techniques on parts
D. Produce a drawing which includes weld symbols

WLD-H2-HO2
Describe Alphabet of Lines
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Distinguish between general and specific notes;
- b. Interpret and apply general and specific notes;
- c. Determine and apply dimensions on a drawing;
- d. Identify basic symbols and abbreviations found on a drawing;
- e. Identify tolerances or limits on a drawing; and,
- f. Identify ANSI limits and fits.

MODULE OUTLINE:

- I. Distinguish Between General and Specific Notes
  - A. General notes
  - B. Specific notes/local notes
- II. Interpret and Apply General and Specific Notes
  - A. General notes applied
    - 1. Title strip/title block
    - 2. Parts list/bill of material
  - B. Interpret general notes
    - 1. Including material
    - 2. General tolerances
    - 3. Heat treatment
    - 4. Pattern information
    - 5. Processes of manufacture
    - 6. Requirements of the product
  - C. Interpret specific notes
    - 1. Apply to specific operations
    - 2. Apply to specific processes of manufacture
    - 3. Apply to the requirements of the product
- III. Determine and Apply Dimensions on a Drawing
  - A. Identify organizations that determine dimension standards
    - 1. American National Standards Institutes (ANSI)
    - 2. International Standards Organization (ISO)
  - B. Determine dimensions on a drawing
    - 1. Size dimensions
    - 2. Location dimensions
  - C. Applying dimensions on a drawing
    - 1. Scale of drawing
    - 2. Techniques of dimensioning
    - 3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
  1. General tolerances
  2. Limit dimensioning
  3. Plus and minus dimensioning
     - a. Unilateral system
     - b. Bilateral system
  4. Single-limit dimensioning
  5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
  1. Clearance fit
  2. Interference fit
  3. Transition fit
  4. Line fit
- B. Limits and fits for cylindrical parts
  1. Running or sliding clearance fits
  2. Locational clearance fits
  3. Transition clearance interference fits
  4. Locational interference fits
  5. Force or shrink fits

WLD-H2-HO3
Describe Alphabet of Lines
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
    A. General/conventional tolerancing
        1. Definitions of general/conventional tolerancing
            a. Dimension
            b. Reference dimension
            c. Feature
            d. Feature of size
            e. Actual size
            f. Stock size
        2. Maximum material condition
        3. Least material condition
        4. Basic fits
        5. Clearance fit
        6. Allowance
        7. Clearance
        8. Force fit
    B. Geometric dimensioning and tolerancing
        1. Definition of geometric dimensioning and tolerancing
        2. Dimensioning rules
        3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
    A. Explain positional / location tolerances
    B. Identify and use geometric position tolerancing symbols
        1. Position
        2. Concentricity
        3. Symmetry
III. Explain and Use Tolerances of Form Symbols
    A. Explain form tolerances
    B. Identify and use tolerances of form symbols
        1. Straightness

        2. Flatness
        3. Circularity
        4. Cylindrical

IV. Explain and Use Profile Tolerances
    A. Explain profile tolerance
    B. Identify and use profile tolerance symbols
        1. Profile of a line
        2. Profile of a surface
        3. Profile of an arc
        4. Profile of irregular curves
        5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
    A. Explain orientation tolerances
    B. Identify and use orientation tolerance symbols
        1. Parallelism
        2. Perpendicularity
        3. Angularity

VI. Explain and Use Runout Tolerances
    A. Explain runouts
        1. Circular
        2. Total
    B. Identify and use runout tolerances symbols
        1. Circular
        2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    A. Maximum Material Condition (MMC)
    B. Regardless of Feature Size (RFS)
    C. Least Material Condition (LMC)
    D. Datum feature symbol
    E. Datum reference frame concept
        1. Primary datum plane
        2. Secondary datum plane
        3. Tertiary datum plane
    F. Datum target symbol
        1. Target point
        2. Target line
        3. Target area

VIII. Explain and Use the Feature Control Frame
    A. Explain feature control frame
    B. Explain the compartments of a feature control frame
        1. Geometric characteristic symbol
        2. Geometric tolerance
        3. Zone descriptor
        4. Material condition symbol
        5. Primary datum reference

        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WLD-H3-HO1

Demonstrate Tape Reading and Measurement Techniques

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the function of measurement tools;
B. Demonstrate the capabilities of shop lay-out tools; and,
C. Understand related terms and definitions.

PRESENTATION OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup
B. Demonstrate how to use the reference on a blueprint
C. Demonstrate how to scribe a line using a square and a protractor
D. Illustrate how to use the print to find angles
E. Define the following: precision, reliability and accuracy
F. Define tolerance and how to find it on a blueprint
G. Demonstrate semi-precision measurements techniques
H. Demonstrate use of steel rules, tapes, micrometers, and vernier calipers
I. Discuss the importance of the tolerance
J. Discriminate between accepted measurement procedures and improper measurement procedures
K. Explain calibration requirements of various precision instruments
L. Illustrate where to locate measurements

Student Activities:

A. Frame and scribe parts for welding and cutting
B. Use measuring techniques on parts
C. Practice use of measurement tools with measurement exercises assigned by the instructor
D. Interpret engineering drawings provided by the instructor

WLD-H3-HO2
Demonstrate Tape Reading and Measurement Techniques
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Distinguish between general and specific notes;
- b. Interpret and apply general and specific notes;
- c. Determine and apply dimensions on a drawing;
- d. Identify basic symbols and abbreviations found on a drawing;
- e. Identify tolerances or limits on a drawing; and,
- f. Identify ANSI limits and fits.

MODULE OUTLINE:

- I. Distinguish Between General and Specific Notes
  - A. General notes
  - B. Specific notes/local notes
- II. Interpret and Apply General and Specific Notes
  - A. General notes applied
    - 1. Title strip/title block
    - 2. Parts list/bill of material
  - B. Interpret general notes
    - 1. Including material
    - 2. General tolerances
    - 3. Heat treatment
    - 4. Pattern information
    - 5. Processes of manufacture
    - 6. Requirements of the product
  - C. Interpret specific notes
    - 1. Apply to specific operations
    - 2. Apply to specific processes of manufacture
    - 3. Apply to the requirements of the product
- III. Determine and Apply Dimensions on a Drawing
  - A. Identify organizations that determine dimension standards
    - 1. American National Standards Institutes (ANSI)
    - 2. International Standards Organization (ISO)
  - B. Determine dimensions on a drawing
    - 1. Size dimensions
    - 2. Location dimensions
  - C. Applying dimensions on a drawing
    - 1. Scale of drawing
    - 2. Techniques of dimensioning
    - 3. Placement of dimensions

4. Choice of dimensions
5. Types of lines used in the dimensioning process
6. Arrowheads used on drawings
7. Leaders used on drawings
8. Dimensioning systems
   a. Fractional
   b. Decimal
   c. Metric
   d. Combination dimensioning
9. Dimension figures
10. Direction of dimension figures
    a. Unidirectional system
    b. Aligned system
11. Dimensioning angles
12. Dimensioning arcs
13. Dimensioning fillets and rounds
14. Identify surfaces to be machined
15. Contour dimensioning
16. Dimensioning of curves
17. Dimensioning of rounded-end shapes
18. Dimensioning of threads
19. Dimensioning of tapers
20. Dimensioning of chamfers
21. Dimensioning shaft centers
22. Dimensioning keyways
23. Dimensioning knurls
    a. Diamond
    b. Straight
24. Dimensioning along curved surfaces
25. Tabular dimensions
26. Dimensioning standards
27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
   A. Traditional terms used to describe various shapes, processes, and sizes
   B. Identify abbreviations used to describe various shapes, processes, and size
   C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
   A. Identify tolerances or limits
      1. Nominal size
      2. Basic size or dimension
      3. Actual size
      4. Tolerance
      5. Limits
      6. Allowance

B. Methods of expressing tolerances
1. General tolerances
2. Limit dimensioning
3. Plus and minus dimensioning
a. Unilateral system
b. Bilateral system
4. Single-limit dimensioning
5. Angular tolerances

VI. Identify ANSI Limits and Fits
A. Fits between mating parts
1. Clearance fit
2. Interference fit
3. Transition fit
4. Line fit
B. Limits and fits for cylindrical parts
1. Running or sliding clearance fits
2. Locational clearance fits
3. Transition clearance interference fits
4. Locational interference fits
5. Force or shrink fits

WLD-H3-HO3
Demonstrate Tape Reading and Measurement Techniques
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry
III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols
    1. Straightness

        - 2. Flatness
        - 3. Circularity
        - 4. Cylindrical
- IV. Explain and Use Profile Tolerances
    - A. Explain profile tolerance
    - B. Identify and use profile tolerance symbols
        - 1. Profile of a line
        - 2. Profile of a surface
        - 3. Profile of an arc
        - 4. Profile of irregular curves
        - 5. Profile of coplanar surfaces
- V. Explain and Use Tolerances of Orientation
    - A. Explain orientation tolerances
    - B. Identify and use orientation tolerance symbols
        - 1. Parallelism
        - 2. Perpendicularity
        - 3. Angularity
- VI. Explain and Use Runout Tolerances
    - A. Explain runouts
        - 1. Circular
        - 2. Total
    - B. Identify and use runout tolerances symbols
        - 1. Circular
        - 2. Total
- VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    - A. Maximum Material Condition (MMC)
    - B. Regardless of Feature Size (RFS)
    - C. Least Material Condition (LMC)
    - D. Datum feature symbol
    - E. Datum reference frame concept
        - 1. Primary datum plane
        - 2. Secondary datum plane
        - 3. Tertiary datum plane
    - F. Datum target symbol
        - 1. Target point
        - 2. Target line
        - 3. Target area
- VIII. Explain and Use the Feature Control Frame
    - A. Explain feature control frame
    - B. Explain the compartments of a feature control frame
        - 1. Geometric characteristic symbol
        - 2. Geometric tolerance
        - 3. Zone descriptor
        - 4. Material condition symbol
        - 5. Primary datum reference

        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WLD-H4-HO1

Use Framing Square to Square Parts

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate the use of shop lay-out tools in a safe manner;
B. Understand the function of shop lay-out tools; and,
C. Demonstrate the capabilities of shop lay-out tools.

MODULE OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup
B. Demonstrate how to use references on a blueprint
C. Demonstrate the application of the framing square
D. Demonstrate how to scribe a line using a square and a protractor
E. Illustrate how to use the print to find angles
F. Define the following: precision, reliability and accuracy
G. Define tolerance and how to find it on a blueprint
H. Demonstrate semi-precision measurements techniques
I. Understand the difference between accepted measurement procedures and improper measurement procedures
J. Illustrate where to locate measurements

Student Activities:

A. Frame and scribe parts for welding and cutting
B. Use measuring techniques on parts
C. Layout a welding job with framing square, jigs, and fixtures

WLD-H4-HO2
Use Framing Square to Square Parts
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- a. Distinguish between general and specific notes;
- b. Interpret and apply general and specific notes;
- c. Determine and apply dimensions on a drawing;
- d. Identify basic symbols and abbreviations found on a drawing;
- e. Identify tolerances or limits on a drawing; and,
- f. Identify ANSI limits and fits.

MODULE OUTLINE:

- I. Distinguish Between General and Specific Notes
  - A. General notes
  - B. Specific notes/local notes
- II. Interpret and Apply General and Specific Notes
  - A. General notes applied
    - 1. Title strip/title block
    - 2. Parts list/bill of material
  - B. Interpret general notes
    - 1. Including material
    - 2. General tolerances
    - 3. Heat treatment
    - 4. Pattern information
    - 5. Processes of manufacture
    - 6. Requirements of the product
  - C. Interpret specific notes
    - 1. Apply to specific operations
    - 2. Apply to specific processes of manufacture
    - 3. Apply to the requirements of the product
- III. Determine and Apply Dimensions on a Drawing
  - A. Identify organizations that determine dimension standards
    - 1. American National Standards Institutes (ANSI)
    - 2. International Standards Organization (ISO)
  - B. Determine dimensions on a drawing
    - 1. Size dimensions
    - 2. Location dimensions
  - C. Applying dimensions on a drawing
    - 1. Scale of drawing
    - 2. Techniques of dimensioning
    - 3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
  - 1. General tolerances
  - 2. Limit dimensioning
  - 3. Plus and minus dimensioning
    - a. Unilateral system
    - b. Bilateral system
  - 4. Single-limit dimensioning
  - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
  - 1. Clearance fit
  - 2. Interference fit
  - 3. Transition fit
  - 4. Line fit
- B. Limits and fits for cylindrical parts
  - 1. Running or sliding clearance fits
  - 2. Locational clearance fits
  - 3. Transition clearance interference fits
  - 4. Locational interference fits
  - 5. Force or shrink fits

WLD-H4-HO3

Use Framing Square to Square Parts

Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Distinguish between conventional and geometric dimensioning and tolerancing;
- b. Explain and use geometric positional tolerancing and symbols;
- c. Explain and use tolerances of form and symbols;
- d. Explain and use the feature control symbol; and,
- e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

- I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  - A. General/conventional tolerancing
    - 1. Definitions of general/conventional tolerancing
      - a. Dimension
      - b. Reference dimension
      - c. Feature
      - d. Feature of size
      - e. Actual size
      - f. Stock size
    - 2. Maximum material condition
    - 3. Least material condition
    - 4. Basic fits
    - 5. Clearance fit
    - 6. Allowance
    - 7. Clearance
    - 8. Force fit
  - B. Geometric dimensioning and tolerancing
    - 1. Definition of geometric dimensioning and tolerancing
    - 2. Dimensioning rules
    - 3. Dimensioning units
- II. Explain and Use Geometric Positional Tolerancing and Symbols
  - A. Explain positional / location tolerances
  - B. Identify and use geometric position tolerancing symbols
    - 1. Position
    - 2. Concentricity
    - 3. Symmetry
- III. Explain and Use Tolerances of Form Symbols
  - A. Explain form tolerances
  - B. Identify and use tolerances of form symbols
    - 1. Straightness

        2. Flatness
        3. Circularity
        4. Cylindrical

IV. Explain and Use Profile Tolerances
    A. Explain profile tolerance
    B. Identify and use profile tolerance symbols
        1. Profile of a line
        2. Profile of a surface
        3. Profile of an arc
        4. Profile of irregular curves
        5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
    A. Explain orientation tolerances
    B. Identify and use orientation tolerance symbols
        1. Parallelism
        2. Perpendicularity
        3. Angularity

VI. Explain and Use Runout Tolerances
    A. Explain runouts
        1. Circular
        2. Total
    B. Identify and use runout tolerances symbols
        1. Circular
        2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    A. Maximum Material Condition (MMC)
    B. Regardless of Feature Size (RFS)
    C. Least Material Condition (LMC)
    D. Datum feature symbol
    E. Datum reference frame concept
        1. Primary datum plane
        2. Secondary datum plane
        3. Tertiary datum plane
    F. Datum target symbol
        1. Target point
        2. Target line
        3. Target area

VIII. Explain and Use the Feature Control Frame
    A. Explain feature control frame
    B. Explain the compartments of a feature control frame
        1. Geometric characteristic symbol
        2. Geometric tolerance
        3. Zone descriptor
        4. Material condition symbol
        5. Primary datum reference

        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

    A. Explain and use additional modifying symbols
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WLD-H5-HO1
Use Level and Other Devices to Verify Layout
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate the use and care of shop lay-out tools; and,

B. Perform leveling methods related to part lay-out for sheet metal, structural and pipe fabrication.

MODULE OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup

B. Demonstrate how to use levels and squaring tools

C. Illustrate how to use the print to establishing layout

D. Demonstrate semi-precision measurements techniques

E. Discuss the importance of fixturing to insure alignment

Student Activities:

A. Use of levels and squaring tools

B. Use measuring techniques on parts

C. Produce a sketch or drawing of the fit-up workplace

WLD-H5-HO2

Use Level and Other Devices to Verify Layout

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning
        3. Placement of dimensions

4. Choice of dimensions
5. Types of lines used in the dimensioning process
6. Arrowheads used on drawings
7. Leaders used on drawings
8. Dimensioning systems
   a. Fractional
   b. Decimal
   c. Metric
   d. Combination dimensioning
9. Dimension figures
10. Direction of dimension figures
   a. Unidirectional system
   b. Aligned system
11. Dimensioning angles
12. Dimensioning arcs
13. Dimensioning fillets and rounds
14. Identify surfaces to be machined
15. Contour dimensioning
16. Dimensioning of curves
17. Dimensioning of rounded-end shapes
18. Dimensioning of threads
19. Dimensioning of tapers
20. Dimensioning of chamfers
21. Dimensioning shaft centers
22. Dimensioning keyways
23. Dimensioning knurls
   a. Diamond
   b. Straight
24. Dimensioning along curved surfaces
25. Tabular dimensions
26. Dimensioning standards
27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
   A. Traditional terms used to describe various shapes, processes, and sizes
   B. Identify abbreviations used to describe various shapes, processes, and size
   C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
   A. Identify tolerances or limits
      1. Nominal size
      2. Basic size or dimension
      3. Actual size
      4. Tolerance
      5. Limits
      6. Allowance

B. Methods of expressing tolerances
    1. General tolerances
    2. Limit dimensioning
    3. Plus and minus dimensioning
        a. Unilateral system
        b. Bilateral system
    4. Single-limit dimensioning
    5. Angular tolerances

VI. Identify ANSI Limits and Fits

A. Fits between mating parts
    1. Clearance fit
    2. Interference fit
    3. Transition fit
    4. Line fit

B. Limits and fits for cylindrical parts
    1. Running or sliding clearance fits
    2. Locational clearance fits
    3. Transition clearance interference fits
    4. Locational interference fits
    5. Force or shrink fits

WLD-H5-HO3
Use Level and Other Devices to Verify Layout
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry
III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols
    1. Straightness

        2. Flatness
        3. Circularity
        4. Cylindrical

IV. Explain and Use Profile Tolerances
    A. Explain profile tolerance
    B. Identify and use profile tolerance symbols
        1. Profile of a line
        2. Profile of a surface
        3. Profile of an arc
        4. Profile of irregular curves
        5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
    A. Explain orientation tolerances
    B. Identify and use orientation tolerance symbols
        1. Parallelism
        2. Perpendicularity
        3. Angularity

VI. Explain and Use Runout Tolerances
    A. Explain runouts
        1. Circular
        2. Total
    B. Identify and use runout tolerances symbols
        1. Circular
        2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    A. Maximum Material Condition (MMC)
    B. Regardless of Feature Size (RFS)
    C. Least Material Condition (LMC)
    D. Datum feature symbol
    E. Datum reference frame concept
        1. Primary datum plane
        2. Secondary datum plane
        3. Tertiary datum plane
    F. Datum target symbol
        1. Target point
        2. Target line
        3. Target area

VIII. Explain and Use the Feature Control Frame
    A. Explain feature control frame
    B. Explain the compartments of a feature control frame
        1. Geometric characteristic symbol
        2. Geometric tolerance
        3. Zone descriptor
        4. Material condition symbol
        5. Primary datum reference

        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

- A. Explain and use additional modifying symbols.
    1. Diameter
    2. Radius R
    3. Reference ( )
    4. Counterbore/spotface L/
    5. Square
    6. Dimension origin O
    7. Slope
    8. Projected tolerance zone
    9. Spherical diameter
    10. Spherical radius
    11. Arc length
    12. Counter sink
    13. Depth
    14. Conical taper
    15. Place, times, or by
    16. Basic dimension

WLD-H6-HO1

Understand and Interpret Shop Drawings for Precise Layout

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand concept related to work area preparation;
B. Understand drawing, sketching and specifications; and,
C. Interpret shop drawings.

MODULE OUTLINE:

Instructional Topics:

A. Interpretation of linear and angular dimensions
B. Use of fractional dimensions and decimal fractions
C. Terms for hole preparation - drill, ream, or flame cut
D. Dimensioning chambers and bevels
E. Dimensioning radius and arc
F. Use of tolerance dimensions
G. Use of thread dimensions
H. Symbols or geometric tolerancing and dimensioning

Student Activities:

A. Interpret engineering drawings by answering questions in each area represented
B. Prepare a sketch that will be critiqued by others in the class for specific meaning and clarity

WLD-H6-HO2
Understand and Interpret Shop Drawings for Precise Layout
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning
        3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
    1. General tolerances
    2. Limit dimensioning
    3. Plus and minus dimensioning
        a. Unilateral system
        b. Bilateral system
    4. Single-limit dimensioning
    5. Angular tolerances
- VI. Identify ANSI Limits and Fits
    - A. Fits between mating parts
        1. Clearance fit
        2. Interference fit
        3. Transition fit
        4. Line fit
    - B. Limits and fits for cylindrical parts
        1. Running or sliding clearance fits
        2. Locational clearance fits
        3. Transition clearance interference fits
        4. Locational interference fits
        5. Force or shrink fits

WLD-H6-HO3
Understand and Interpret Shop Drawings for Precise Layout
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing

---

MODULE OUTLINE:

- I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  - A. General/conventional tolerancing
    - 1. Definitions of general/conventional tolerancing
      - a. Dimension
      - b. Reference dimension
      - c. Feature
      - d. Feature of size
      - e. Actual size
      - f. Stock size
    - 2. Maximum material condition
    - 3. Least material condition
    - 4. Basic fits
    - 5. Clearance fit
    - 6. Allowance
    - 7. Clearance
    - 8. Force fit
  - B. Geometric dimensioning and tolerancing
    - 1. Definition of geometric dimensioning and tolerancing
    - 2. Dimensioning rules
    - 3. Dimensioning units
- II. Explain and Use Geometric Positional Tolerancing and Symbols
  - A. Explain positional / location tolerances
  - B. Identify and use geometric position tolerancing symbols
    - 1. Position
    - 2. Concentricity
    - 3. Symmetry
- III. Explain and Use Tolerances of Form Symbols
  - A. Explain form tolerances
  - B. Identify and use tolerances of form symbols
    - 1. Straightness

    - 2. Flatness
    - 3. Circularity
    - 4. Cylindrical
- IV. Explain and Use Profile Tolerances
  - A. Explain profile tolerance
  - B. Identify and use profile tolerance symbols
    - 1. Profile of a line
    - 2. Profile of a surface
    - 3. Profile of an arc
    - 4. Profile of irregular curves
    - 5. Profile of coplanar surfaces
- V. Explain and Use Tolerances of Orientation
  - A. Explain orientation tolerances
  - B. Identify and use orientation tolerance symbols
    - 1. Parallelism
    - 2. Perpendicularity
    - 3. Angularity
- VI. Explain and Use Runout Tolerances
  - A. Explain runouts
    - 1. Circular
    - 2. Total
  - B. Identify and use runout tolerances symbols
    - 1. Circular
    - 2. Total
- VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  - A. Maximum Material Condition (MMC)
  - B. Regardless of Feature Size (RFS)
  - C. Least Material Condition (LMC)
  - D. Datum feature symbol
  - E. Datum reference frame concept
    - 1. Primary datum plane
    - 2. Secondary datum plane
    - 3. Tertiary datum plane
  - F. Datum target symbol
    - 1. Target point
    - 2. Target line
    - 3. Target area
- VIII. Explain and Use the Feature Control Frame
  - A. Explain feature control frame
  - B. Explain the compartments of a feature control frame
    - 1. Geometric characteristic symbol
    - 2. Geometric tolerance
    - 3. Zone descriptor
    - 4. Material condition symbol
    - 5. Primary datum reference

        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WLD-H6-HO4

Understand and Interpret Shop Drawings for Precise layout

Attachment 4: **MASTER** Handout No. 4

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify types of drawings;
b. Identify parts of a drawing and list components of each;
c. Identify types of lines on a drawing;
d. List and describe the different views found on a drawing;
e. List and apply the three primary planes of projection;
f. List and apply the six principal views;
g. Apply auxiliary views; and,
h. Apply sectional views.

Module Outline:

I. Interpret and Understand Basic Layout of Drawings
  A. ANSI & ISO sheet size layout
  B. ANSI & ISO forms of lettering arrangements
II. Interpret and Understand Types of Drawings
  A. Orthographic and multi-view projection
  B. Perspective or central projection
  C. Oblique projection
  D. Axonometric projection
III. Identify Parts of a Blue Print/Drawing and List Components of Each
  A. Body
  B. Title block
    1. Drawing number
    2. Drawing title
    3. Scale
    4. Signatures
    5. Job number
    6. Material list number
    7. Reference drawings
    8. Distribution section
    9. Revision
    10. Work order number
  C. Bill of Materials
    1. Piece mark number
    2. Number of pieces required for each piece mark
    3. Description of materials
    4. Traceability requirements
    5. Material specifications

        6. Length
        7. Gross weight
        8. Total weight

IV. Identify Types of Lines on a Drawing
    A. Visible line
    B. Hidden line
    C. Center line
    D. Section line
    E. Dimension line
    F. Extension line
    G. Leaders line
    H. Cutting plane/viewing plane line
    I. Short-break line
    J. Long-break line
    K. Phantom line
    L. Stitch line
    M. Chain line
    N. Cylindrical break/conventional break lines

V. List and Describe the Different Views Found on a Drawing
    A. One view
        1. Sphere
        2. Plate
    B. Two view
        1. Cylinder
        2. Rectangle
    C. Three view
        1. Pyramids
        2. Multi-view projection

VI. List and Apply the Three Primary Planes of Projection
    A. Frontal projection plane
    B. Profile projection plane
        1. Right side
        2. Left side
    C. Horizontal projection plane

VII. List and Apply the Six Principal Views
    A. Front view
    B. Rear view
    C. Right side view
    D. Left side view
    E. Top view
    F. Bottom view

VIII. List and Apply Auxiliary Views
    A. Surfaces needing auxiliary views
        1. Inclined surfaces
        2. Oblique surfaces

    B. Primary auxiliary views
    C. Secondary auxiliary views
    D. To generate an auxiliary view
        1. Folding-line method
        2. Reference-plane method
    E. Classifications of auxiliary views
        1. Depth auxiliary views
        2. Height auxiliary views
        3. Width auxiliary views
    F. Dihedral angles
    G. Partial auxiliary views
    H. Half auxiliary views
    I. Auxiliary sections
    J. Basic four uses of auxiliary views
        1. True length of line
        2. Point view of line
        3. Edge view of plane
        4. True size of plane

IX. List and Apply Sectional Views
    A. Need for sectional views
    B. Cutting plane
        1. Direction
        2. Labels
        3. Alternate styles
    C. Section lining
        1. Techniques
        2. Symbols
    D. Types of sectional views
        1. Full section
        2. Half/partial section
        3. Broken-out section
        4. Revolved section
        5. Removed section
        6. Offset section
        7. Aligned section
        8. Auxiliary section
        9. Partial section

WLD-H7-HO1
Demonstrate Knowledge of Welding Symbols
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the basic elements if the A.W.S. Welding Symbol System;
B. Identify welding symbols for basic joints for weldment fabrication;
C. Use fillet weld in combination with other symbols;
D. Understand supplementary symbols and arrangements;
E. Understand plug and slot-weld symbols;
F. Understand spot weld and seam weld symbols;
G. Understand groove weld symbols;
H. Understand backing, back, melt through and surfacing symbols;
I. Understand flange and combination weld symbols; and,
J. Compare AWS symbols to international symbols.

MODULE OUTLINE:

Instructional Topics:

A. Present the basic elements if the A.W.S. Welding Symbol System
B. Present welding symbols for basic joints for weldment fabrication
C. Present fillet weld in combination with other symbols
D. Present supplementary symbols and arrangements
E. Present plug and slot-weld symbols
F. Present spot weld and seam weld symbols
G. Present groove weld symbols
H. Present backing, back, melt through and surfacing symbols
I. Present flange and combination weld symbols
J. Compare AWS symbols to international symbols

Student Activities:

A. Identify AWS symbols on drawings
B. Identify ISO symbols on drawings
C. Plan a job that includes symbols and specifications from AWS and ISO

WLD-H7-HO2

Demonstrate Knowledge of Welding Symbols

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning
        3. Placement of dimensions

    4. Choice of dimensions
    5. Types of lines used in the dimensioning process
    6. Arrowheads used on drawings
    7. Leaders used on drawings
    8. Dimensioning systems
        a. Fractional
        b. Decimal
        c. Metric
        d. Combination dimensioning
    9. Dimension figures
    10. Direction of dimension figures
        a. Unidirectional system
        b. Aligned system
    11. Dimensioning angles
    12. Dimensioning arcs
    13. Dimensioning fillets and rounds
    14. Identify surfaces to be machined
    15. Contour dimensioning
    16. Dimensioning of curves
    17. Dimensioning of rounded-end shapes
    18. Dimensioning of threads
    19. Dimensioning of tapers
    20. Dimensioning of chamfers
    21. Dimensioning shaft centers
    22. Dimensioning keyways
    23. Dimensioning knurls
        a. Diamond
        b. Straight
    24. Dimensioning along curved surfaces
    25. Tabular dimensions
    26. Dimensioning standards
    27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing

  A. Traditional terms used to describe various shapes, processes, and sizes

  B. Identify abbreviations used to describe various shapes, processes, and size

  C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing

  A. Identify tolerances or limits

    1. Nominal size
    2. Basic size or dimension
    3. Actual size
    4. Tolerance
    5. Limits
    6. Allowance

- B. Methods of expressing tolerances
    - 1. General tolerances
    - 2. Limit dimensioning
    - 3. Plus and minus dimensioning
        - a. Unilateral system
        - b. Bilateral system
    - 4. Single-limit dimensioning
    - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
    - 1. Clearance fit
    - 2. Interference fit
    - 3. Transition fit
    - 4. Line fit
- B. Limits and fits for cylindrical parts
    - 1. Running or sliding clearance fits
    - 2. Locational clearance fits
    - 3. Transition clearance interference fits
    - 4. Locational interference fits
    - 5. Force or shrink fits

WLD-H7-HO3

Demonstrate Knowledge of Welding Symbols

Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Distinguish between conventional and geometric dimensioning and tolerancing;
- b. Explain and use geometric positional tolerancing and symbols;
- c. Explain and use tolerances of form and symbols;
- d. Explain and use the feature control symbol; and,
- e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

- I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  - A. General/conventional tolerancing
    - 1. Definitions of general/conventional tolerancing
      - a. Dimension
      - b. Reference dimension
      - c. Feature
      - d. Feature of size
      - e. Actual size
      - f. Stock size
    - 2. Maximum material condition
    - 3. Least material condition
    - 4. Basic fits
    - 5. Clearance fit
    - 6. Allowance
    - 7. Clearance
    - 8. Force fit
  - B. Geometric dimensioning and tolerancing
    - 1. Definition of geometric dimensioning and tolerancing
    - 2. Dimensioning rules
    - 3. Dimensioning units
- II. Explain and Use Geometric Positional Tolerancing and Symbols
  - A. Explain positional / location tolerances
  - B. Identify and use geometric position tolerancing symbols
    - 1. Position
    - 2. Concentricity
    - 3. Symmetry
- III. Explain and Use Tolerances of Form Symbols
  - A. Explain form tolerances
  - B. Identify and use tolerances of form symbols
    - 1. Straightness

    2. Flatness
    3. Circularity
    4. Cylindrical
IV. Explain and Use Profile Tolerances
  A. Explain profile tolerance
  B. Identify and use profile tolerance symbols
    1. Profile of a line
    2. Profile of a surface
    3. Profile of an arc
    4. Profile of irregular curves
    5. Profile of coplanar surfaces
V. Explain and Use Tolerances of Orientation
  A. Explain orientation tolerances
  B. Identify and use orientation tolerance symbols
    1. Parallelism
    2. Perpendicularity
    3. Angularity
VI. Explain and Use Runout Tolerances
  A. Explain runouts
    1. Circular
    2. Total
  B. Identify and use runout tolerances symbols
    1. Circular
    2. Total
VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  A. Maximum Material Condition (MMC)
  B. Regardless of Feature Size (RFS)
  C. Least Material Condition (LMC)
  D. Datum feature symbol
  E. Datum reference frame concept
    1. Primary datum plane
    2. Secondary datum plane
    3. Tertiary datum plane
  F. Datum target symbol
    1. Target point
    2. Target line
    3. Target area
VIII. Explain and Use the Feature Control Frame
  A. Explain feature control frame
  B. Explain the compartments of a feature control frame
    1. Geometric characteristic symbol
    2. Geometric tolerance
    3. Zone descriptor
    4. Material condition symbol
    5. Primary datum reference

6. Secondary datum reference
7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

A. Explain and use additional modifying symbols.

1. Diameter
2. Radius R
3. Reference ( )
4. Counterbore/spotface L/
5. Square
6. Dimension origin O
7. Slope
8. Projected tolerance zone
9. Spherical diameter
10. Spherical radius
11. Arc length
12. Counter sink
13. Depth
14. Conical taper
15. Place, times, or by
16. Basic dimension

WLD-H8-HO1
Identify Various Structural Shapes and Their Respective Parts
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand structural shapes; and,

B. Understand how to measure structural shapes.

MODULE OUTLINE:

Instructional Topics:

A. Structural shapes frequently encountered by the welder

B. How sizes are specified

C. Measurement techniques for structural shapes

D. Use of gages for sheet steel, brass, aluminum, copper and others

E. Weight and size specifications for reinforcing members of the structure

F. Sizing of pipe

G. Structural beams classified as four shapes

H. Ordering structural metal

Student Activities:

A. Use of appropriate measurement techniques for structural shapes

B. Selection of gages for sheet metal

C. Ordering of materials

WLD-H8-HO2

Identify Various Structural Shapes and Their Respective Parts

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning
        3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
  - 1. General tolerances
  - 2. Limit dimensioning
  - 3. Plus and minus dimensioning
    - a. Unilateral system
    - b. Bilateral system
  - 4. Single-limit dimensioning
  - 5. Angular tolerances
- VI. Identify ANSI Limits and Fits
  - A. Fits between mating parts
    - 1. Clearance fit
    - 2. Interference fit
    - 3. Transition fit
    - 4. Line fit
  - B. Limits and fits for cylindrical parts
    - 1. Running or sliding clearance fits
    - 2. Locational clearance fits
    - 3. Transition clearance interference fits
    - 4. Locational interference fits
    - 5. Force or shrink fits

WLD-H8-HO3

Identify Various Structural Shapes and Their Respective Parts

Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Distinguish between conventional and geometric dimensioning and tolerancing;
- b. Explain and use geometric positional tolerancing and symbols;
- c. Explain and use tolerances of form and symbols;
- d. Explain and use the feature control symbol; and,
- e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

- I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  - A. General/conventional tolerancing
    - 1. Definitions of general/conventional tolerancing
      - a. Dimension
      - b. Reference dimension
      - c. Feature
      - d. Feature of size
      - e. Actual size
      - f. Stock size
    - 2. Maximum material condition
    - 3. Least material condition
    - 4. Basic fits
    - 5. Clearance fit
    - 6. Allowance
    - 7. Clearance
    - 8. Force fit
  - B. Geometric dimensioning and tolerancing
    - 1. Definition of geometric dimensioning and tolerancing
    - 2. Dimensioning rules
    - 3. Dimensioning units
- II. Explain and Use Geometric Positional Tolerancing and Symbols
  - A. Explain positional / location tolerances
  - B. Identify and use geometric position tolerancing symbols
    - 1. Position
    - 2. Concentricity
    - 3. Symmetry
- III. Explain and Use Tolerances of Form Symbols
  - A. Explain form tolerances
  - B. Identify and use tolerances of form symbols
    - 1. Straightness

    - 2. Flatness
    - 3. Circularity
    - 4. Cylindrical
- IV. Explain and Use Profile Tolerances
  - A. Explain profile tolerance
  - B. Identify and use profile tolerance symbols
    - 1. Profile of a line
    - 2. Profile of a surface
    - 3. Profile of an arc
    - 4. Profile of irregular curves
    - 5. Profile of coplanar surfaces
- V. Explain and Use Tolerances of Orientation
  - A. Explain orientation tolerances
  - B. Identify and use orientation tolerance symbols
    - 1. Parallelism
    - 2. Perpendicularity
    - 3. Angularity
- VI. Explain and Use Runout Tolerances
  - A. Explain runouts
    - 1. Circular
    - 2. Total
  - B. Identify and use runout tolerances symbols
    - 1. Circular
    - 2. Total
- VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  - A. Maximum Material Condition (MMC)
  - B. Regardless of Feature Size (RFS)
  - C. Least Material Condition (LMC)
  - D. Datum feature symbol
  - E. Datum reference frame concept
    - 1. Primary datum plane
    - 2. Secondary datum plane
    - 3. Tertiary datum plane
  - F. Datum target symbol
    - 1. Target point
    - 2. Target line
    - 3. Target area
- VIII. Explain and Use the Feature Control Frame
  - A. Explain feature control frame
  - B. Explain the compartments of a feature control frame
    - 1. Geometric characteristic symbol
    - 2. Geometric tolerance
    - 3. Zone descriptor
    - 4. Material condition symbol
    - 5. Primary datum reference

        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WLD-H9-HO1
Identify Structural Components and Support Frameworks of Buildings and Their Components
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand metal structures and foundation of buildings

---

MODULE OUTLINE:

Instructional Topics:

A. Discuss the types of metal beams used in building construction
B. Discuss the types of metal piping used in building and fluid distribution systems
C. Discuss methods of construction that require welding skills

Student Activities:

A. Visit a construction site where metal beams and piping are being installed
B. Demonstrate cutting or welding of metal components used in construction

WLD-H9-HO2
Identify Structural Components and Support Frameworks of Buildings and Their Components
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning

        3. Placement of dimensions
        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits

- 6. Allowance
- B. Methods of expressing tolerances
  - 1. General tolerances
  - 2. Limit dimensioning
  - 3. Plus and minus dimensioning
    - a. Unilateral system
    - b. Bilateral system
  - 4. Single-limit dimensioning
  - 5. Angular tolerances
- VI. Identify ANSI Limits and Fits
  - A. Fits between mating parts
    - 1. Clearance fit
    - 2. Interference fit
    - 3. Transition fit
    - 4. Line fit
  - B. Limits and fits for cylindrical parts
    - 1. Running or sliding clearance fits
    - 2. Locational clearance fits
    - 3. Transition clearance interference fits
    - 4. Locational interference fits
    - 5. Force or shrink fits

WLD-H9-HO3
Identify Structural Components and Support Frameworks of Buildings and Their Components
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry
III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols

      1. Straightness
      2. Flatness
      3. Circularity
      4. Cylindrical

IV. Explain and Use Profile Tolerances
   A. Explain profile tolerance
   B. Identify and use profile tolerance symbols
      1. Profile of a line
      2. Profile of a surface
      3. Profile of an arc
      4. Profile of irregular curves
      5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
   A. Explain orientation tolerances
   B. Identify and use orientation tolerance symbols
      1. Parallelism
      2. Perpendicularity
      3. Angularity

VI. Explain and Use Runout Tolerances
   A. Explain runouts
      1. Circular
      2. Total
   B. Identify and use runout tolerances symbols
      1. Circular
      2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
   A. Maximum Material Condition (MMC)
   B. Regardless of Feature Size (RFS)
   C. Least Material Condition (LMC)
   D. Datum feature symbol
   E. Datum reference frame concept
      1. Primary datum plane
      2. Secondary datum plane
      3. Tertiary datum plane
   F. Datum target symbol
      1. Target point
      2. Target line
      3. Target area

VIII. Explain and Use the Feature Control Frame
   A. Explain feature control frame
   B. Explain the compartments of a feature control frame
      1. Geometric characteristic symbol
      2. Geometric tolerance
      3. Zone descriptor
      4. Material condition symbol

5. Primary datum reference
6. Secondary datum reference
7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

A. Explain and use additional modifying symbols.

1. Diameter
2. Radius R
3. Reference ( )
4. Counterbore/spotface L/
5. Square
6. Dimension origin O
7. Slope
8. Projected tolerance zone
9. Spherical diameter
10. Spherical radius
11. Arc length
12. Counter sink
13. Depth
14. Conical taper
15. Place, times, or by
16. Basic dimension

WLD-H10-HO1
Describe Proper Placement of Stiffeners and Supports When Modifying Existing Structures
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand gussets and cross members for support of structures

---

MODULE OUTLINE:

Instructional Topics:

A. Use of welded supports in structures
B. Selection of metal support members
C. Types of welds for supports
D. Verification of quality in welds
E. Codes and standards for supporting structures

Student Activities:

A. Visit a construction site where this work is done
B. Visit a metals manufacturer where design work is performed

WLD-H10-HO2
Describe Proper Placement of Stiffeners and Supports When Modifying Existing Structures
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
  A. General notes
  B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
  A. General notes applied
    1. Title strip/title block
    2. Parts list/bill of material
  B. Interpret general notes
    1. Including material
    2. General tolerances
    3. Heat treatment
    4. Pattern information
    5. Processes of manufacture
    6. Requirements of the product
  C. Interpret specific notes
    1. Apply to specific operations
    2. Apply to specific processes of manufacture
    3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
  A. Identify organizations that determine dimension standards
    1. American National Standards Institutes (ANSI)
    2. International Standards Organization (ISO)
  B. Determine dimensions on a drawing
    1. Size dimensions
    2. Location dimensions
  C. Applying dimensions on a drawing
    1. Scale of drawing
    2. Techniques of dimensioning

    3. Placement of dimensions
    4. Choice of dimensions
    5. Types of lines used in the dimensioning process
    6. Arrowheads used on drawings
    7. Leaders used on drawings
    8. Dimensioning systems
        a. Fractional
        b. Decimal
        c. Metric
        d. Combination dimensioning
    9. Dimension figures
    10. Direction of dimension figures
        a. Unidirectional system
        b. Aligned system
    11. Dimensioning angles
    12. Dimensioning arcs
    13. Dimensioning fillets and rounds
    14. Identify surfaces to be machined
    15. Contour dimensioning
    16. Dimensioning of curves
    17. Dimensioning of rounded-end shapes
    18. Dimensioning of threads
    19. Dimensioning of tapers
    20. Dimensioning of chamfers
    21. Dimensioning shaft centers
    22. Dimensioning keyways
    23. Dimensioning knurls
        a. Diamond
        b. Straight
    24. Dimensioning along curved surfaces
    25. Tabular dimensions
    26. Dimensioning standards
    27. Coordinate dimensioning
IV. Identify Basic Symbols and Abbreviations Found on a Drawing
  A. Traditional terms used to describe various shapes, processes, and sizes
  B. Identify abbreviations used to describe various shapes, processes, and size
  C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations
V. Identify Tolerances or Limits on a Drawing
  A. Identify tolerances or limits
    1. Nominal size
    2. Basic size or dimension
    3. Actual size
    4. Tolerance
    5. Limits

        6. Allowance
    B. Methods of expressing tolerances
        1. General tolerances
        2. Limit dimensioning
        3. Plus and minus dimensioning
            a. Unilateral system
            b. Bilateral system
        4. Single-limit dimensioning
        5. Angular tolerances
VI. Identify ANSI Limits and Fits
    A. Fits between mating parts
        1. Clearance fit
        2. Interference fit
        3. Transition fit
        4. Line fit
    B. Limits and fits for cylindrical parts
        1. Running or sliding clearance fits
        2. Locational clearance fits
        3. Transition clearance interference fits
        4. Locational interference fits
        5. Force or shrink fits

WLD-H10-HO3
Describe Proper Placement of Stiffeners and Supports When Modifying Existing Structures
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  A. General/conventional tolerancing
    1. Definitions of general/conventional tolerancing
      a. Dimension
      b. Reference dimension
      c. Feature
      d. Feature of size
      e. Actual size
      f. Stock size
    2. Maximum material condition
    3. Least material condition
    4. Basic fits
    5. Clearance fit
    6. Allowance
    7. Clearance
    8. Force fit
  B. Geometric dimensioning and tolerancing
    1. Definition of geometric dimensioning and tolerancing
    2. Dimensioning rules
    3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
  A. Explain positional / location tolerances
  B. Identify and use geometric position tolerancing symbols
    1. Position
    2. Concentricity
    3. Symmetry
III. Explain and Use Tolerances of Form Symbols
  A. Explain form tolerances
  B. Identify and use tolerances of form symbols

        1. Straightness
        2. Flatness
        3. Circularity
        4. Cylindrical

IV. Explain and Use Profile Tolerances
    A. Explain profile tolerance
    B. Identify and use profile tolerance symbols
        1. Profile of a line
        2. Profile of a surface
        3. Profile of an arc
        4. Profile of irregular curves
        5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
    A. Explain orientation tolerances
    B. Identify and use orientation tolerance symbols
        1. Parallelism
        2. Perpendicularity
        3. Angularity

VI. Explain and Use Runout Tolerances
    A. Explain runouts
        1. Circular
        2. Total
    B. Identify and use runout tolerances symbols
        1. Circular
        2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    A. Maximum Material Condition (MMC)
    B. Regardless of Feature Size (RFS)
    C. Least Material Condition (LMC)
    D. Datum feature symbol
    E. Datum reference frame concept
        1. Primary datum plane
        2. Secondary datum plane
        3. Tertiary datum plane
    F. Datum target symbol
        1. Target point
        2. Target line
        3. Target area

VIII. Explain and Use the Feature Control Frame
    A. Explain feature control frame
    B. Explain the compartments of a feature control frame
        1. Geometric characteristic symbol
        2. Geometric tolerance
        3. Zone descriptor
        4. Material condition symbol

        5. Primary datum reference
        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WLD-H11-HO1
Identify Fillet Weld Sizes for Various Thicknesses of Base Metals
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand blue print requirements for welds; and,
B. Understand weld size gauges.

MODULE OUTLINE:

Instructional Topics:

A. Selection of the base metals
B. Sizing of the weld
C. Use of gages
D. Length of weld and extent of welding
E. Pitch, contour, and finishing

Student Activities:

A. Practice use of symbols for fillet welds
B. Interpret specifications and plan work from a drawing with fillet welds

WLD-H11-HO2

Identify Fillet Weld Sizes for Various Thicknesses of Base Metals

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
  A. General notes
  B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
  A. General notes applied
    1. Title strip/title block
    2. Parts list/bill of material
  B. Interpret general notes
    1. Including material
    2. General tolerances
    3. Heat treatment
    4. Pattern information
    5. Processes of manufacture
    6. Requirements of the product
  C. Interpret specific notes
    1. Apply to specific operations
    2. Apply to specific processes of manufacture
    3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
  A. Identify organizations that determine dimension standards
    1. American National Standards Institutes (ANSI)
    2. International Standards Organization (ISO)
  B. Determine dimensions on a drawing
    1. Size dimensions
    2. Location dimensions
  C. Applying dimensions on a drawing
    1. Scale of drawing
    2. Techniques of dimensioning
    3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

B. Methods of expressing tolerances
   1. General tolerances
   2. Limit dimensioning
   3. Plus and minus dimensioning
      a. Unilateral system
      b. Bilateral system
   4. Single-limit dimensioning
   5. Angular tolerances

VI. Identify ANSI Limits and Fits
   A. Fits between mating parts
      1. Clearance fit
      2. Interference fit
      3. Transition fit
      4. Line fit
   B. Limits and fits for cylindrical parts
      1. Running or sliding clearance fits
      2. Locational clearance fits
      3. Transition clearance interference fits
      4. Locational interference fits
      5. Force or shrink fits

WLD-H11-HO3
Identify Fillet Weld Sizes for Various Thicknesses of Base Metals
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

- I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  - A. General/conventional tolerancing
    - 1. Definitions of general/conventional tolerancing
      - a. Dimension
      - b. Reference dimension
      - c. Feature
      - d. Feature of size
      - e. Actual size
      - f. Stock size
    - 2. Maximum material condition
    - 3. Least material condition
    - 4. Basic fits
    - 5. Clearance fit
    - 6. Allowance
    - 7. Clearance
    - 8. Force fit
  - B. Geometric dimensioning and tolerancing
    - 1. Definition of geometric dimensioning and tolerancing
    - 2. Dimensioning rules
    - 3. Dimensioning units
- II. Explain and Use Geometric Positional Tolerancing and Symbols
  - A. Explain positional / location tolerances
  - B. Identify and use geometric position tolerancing symbols
    - 1. Position
    - 2. Concentricity
    - 3. Symmetry
- III. Explain and Use Tolerances of Form Symbols
  - A. Explain form tolerances
  - B. Identify and use tolerances of form symbols

1. Straightness
2. Flatness
3. Circularity
4. Cylindrical

IV. Explain and Use Profile Tolerances
   A. Explain profile tolerance
   B. Identify and use profile tolerance symbols
      1. Profile of a line
      2. Profile of a surface
      3. Profile of an arc
      4. Profile of irregular curves
      5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
   A. Explain orientation tolerances
   B. Identify and use orientation tolerance symbols
      1. Parallelism
      2. Perpendicularity
      3. Angularity

VI. Explain and Use Runout Tolerances
   A. Explain runouts
      1. Circular
      2. Total
   B. Identify and use runout tolerances symbols
      1. Circular
      2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
   A. Maximum Material Condition (MMC)
   B. Regardless of Feature Size (RFS)
   C. Least Material Condition (LMC)
   D. Datum feature symbol
   E. Datum reference frame concept
      1. Primary datum plane
      2. Secondary datum plane
      3. Tertiary datum plane
   F. Datum target symbol
      1. Target point
      2. Target line
      3. Target area

VIII. Explain and Use the Feature Control Frame
   A. Explain feature control frame
   B. Explain the compartments of a feature control frame
      1. Geometric characteristic symbol
      2. Geometric tolerance
      3. Zone descriptor
      4. Material condition symbol

        5. Primary datum reference
        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WLD-H12-HO1
Describe Proper Sequence When Cutting Various Shapes To Structural Drawing Specs
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand removal of components to specifications; AND,
B. Understand replacement of components to specification.

MODULE OUTLINE:

Instructional Topics:

A. Preparation of the base material
B. Grinding and heat treating required
C. Surfaces and edges to be welded (surface roughness)
D. How to avoid cutting beyond prescribed lines
E. Inspection and repair of cut edges
F. Limits of acceptability and repair of discontinuities
G. Control of distortion and shrinkage

Student Activities:

A. Practice cutting to specification
B. Examine quality of finished part

WLD-H12-HO2
Describe Proper Sequence When Cutting Various Shapes To Structural Drawing Specs
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning

        3. Placement of dimensions
        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits

    6. Allowance
  B. Methods of expressing tolerances
    1. General tolerances
    2. Limit dimensioning
    3. Plus and minus dimensioning
      a. Unilateral system
      b. Bilateral system
    4. Single-limit dimensioning
    5. Angular tolerances
VI. Identify ANSI Limits and Fits
  A. Fits between mating parts
    1. Clearance fit
    2. Interference fit
    3. Transition fit
    4. Line fit
  B. Limits and fits for cylindrical parts
    1. Running or sliding clearance fits
    2. Locational clearance fits
    3. Transition clearance interference fits
    4. Locational interference fits
    5. Force or shrink fits

WLD-H12-HO3
Describe Proper Sequence When Cutting Various Shapes To Structural Drawing Specs
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

- I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
  - A. General/conventional tolerancing
    - 1. Definitions of general/conventional tolerancing
      - a. Dimension
      - b. Reference dimension
      - c. Feature
      - d. Feature of size
      - e. Actual size
      - f. Stock size
    - 2. Maximum material condition
    - 3. Least material condition
    - 4. Basic fits
    - 5. Clearance fit
    - 6. Allowance
    - 7. Clearance
    - 8. Force fit
  - B. Geometric dimensioning and tolerancing
    - 1. Definition of geometric dimensioning and tolerancing
    - 2. Dimensioning rules
    - 3. Dimensioning units
- II. Explain and Use Geometric Positional Tolerancing and Symbols
  - A. Explain positional / location tolerances
  - B. Identify and use geometric position tolerancing symbols
    - 1. Position
    - 2. Concentricity
    - 3. Symmetry
- III. Explain and Use Tolerances of Form Symbols
  - A. Explain form tolerances

B. Identify and use tolerances of form symbols
    1. Straightness
    2. Flatness
    3. Circularity
    4. Cylindrical

IV. Explain and Use Profile Tolerances
  A. Explain profile tolerance
  B. Identify and use profile tolerance symbols
    1. Profile of a line
    2. Profile of a surface
    3. Profile of an arc
    4. Profile of irregular curves
    5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
  A. Explain orientation tolerances
  B. Identify and use orientation tolerance symbols
    1. Parallelism
    2. Perpendicularity
    3. Angularity

VI. Explain and Use Runout Tolerances
  A. Explain runouts
    1. Circular
    2. Total
  B. Identify and use runout tolerances symbols
    1. Circular
    2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  A. Maximum Material Condition (MMC)
  B. Regardless of Feature Size (RFS)
  C. Least Material Condition (LMC)
  D. Datum feature symbol
  E. Datum reference frame concept
    1. Primary datum plane
    2. Secondary datum plane
    3. Tertiary datum plane
  F. Datum target symbol
    1. Target point
    2. Target line
    3. Target area

VIII. Explain and Use the Feature Control Frame
  A. Explain feature control frame
  B. Explain the compartments of a feature control frame
    1. Geometric characteristic symbol
    2. Geometric tolerance
    3. Zone descriptor

        4. Material condition symbol
        5. Primary datum reference
        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WLD-H13-HO1

Describe Methods for Layout Slopes and Rolling Tolerances

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the references of a blueprint and drawing; and,
B. Understand precision, reliability, accuracy.

MODULE OUTLINE:

Instructional Topics:

A. Demonstrate how to use the reference on a blueprint
B. Define precision, reliability and accuracy
C. Define tolerance and how to find it on a blueprint
D. Demonstrate semi-precision measurement techniques
E. Discuss the importance of the tolerance
F. Discriminate between accepted measurement procedures and improper measurement procedures

Student Activities:

A. Use measuring techniques on parts
B. Produce a drawing which includes weld symbols

WLD-H13-HO2
Describe Methods for Layout Slopes and Rolling Tolerances
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
  A. General notes
  B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
  A. General notes applied
    1. Title strip/title block
    2. Parts list/bill of material
  B. Interpret general notes
    1. Including material
    2. General tolerances
    3. Heat treatment
    4. Pattern information
    5. Processes of manufacture
    6. Requirements of the product
  C. Interpret specific notes
    1. Apply to specific operations
    2. Apply to specific processes of manufacture
    3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
  A. Identify organizations that determine dimension standards
    1. American National Standards Institutes (ANSI)
    2. International Standards Organization (ISO)
  B. Determine dimensions on a drawing
    1. Size dimensions
    2. Location dimensions
  C. Applying dimensions on a drawing
    1. Scale of drawing
    2. Techniques of dimensioning
    3. Placement of dimensions

    4. Choice of dimensions
    5. Types of lines used in the dimensioning process
    6. Arrowheads used on drawings
    7. Leaders used on drawings
    8. Dimensioning systems
        a. Fractional
        b. Decimal
        c. Metric
        d. Combination dimensioning
    9. Dimension figures
    10. Direction of dimension figures
        a. Unidirectional system
        b. Aligned system
    11. Dimensioning angles
    12. Dimensioning arcs
    13. Dimensioning fillets and rounds
    14. Identify surfaces to be machined
    15. Contour dimensioning
    16. Dimensioning of curves
    17. Dimensioning of rounded-end shapes
    18. Dimensioning of threads
    19. Dimensioning of tapers
    20. Dimensioning of chamfers
    21. Dimensioning shaft centers
    22. Dimensioning keyways
    23. Dimensioning knurls
        a. Diamond
        b. Straight
    24. Dimensioning along curved surfaces
    25. Tabular dimensions
    26. Dimensioning standards
    27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
  A. Traditional terms used to describe various shapes, processes, and sizes
  B. Identify abbreviations used to describe various shapes, processes, and size
  C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
  A. Identify tolerances or limits
    1. Nominal size
    2. Basic size or dimension
    3. Actual size
    4. Tolerance
    5. Limits
    6. Allowance

- B. Methods of expressing tolerances
  - 1. General tolerances
  - 2. Limit dimensioning
  - 3. Plus and minus dimensioning
    - a. Unilateral system
    - b. Bilateral system
  - 4. Single-limit dimensioning
  - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
  - 1. Clearance fit
  - 2. Interference fit
  - 3. Transition fit
  - 4. Line fit
- B. Limits and fits for cylindrical parts
  - 1. Running or sliding clearance fits
  - 2. Locational clearance fits
  - 3. Transition clearance interference fits
  - 4. Locational interference fits
  - 5. Force or shrink fits

WLD-H13-HO3
Describe Methods for Layout Slopes and Rolling Tolerances
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
    A. General/conventional tolerancing
        1. Definitions of general/conventional tolerancing
            a. Dimension
            b. Reference dimension
            c. Feature
            d. Feature of size
            e. Actual size
            f. Stock size
        2. Maximum material condition
        3. Least material condition
        4. Basic fits
        5. Clearance fit
        6. Allowance
        7. Clearance
        8. Force fit
    B. Geometric dimensioning and tolerancing
        1. Definition of geometric dimensioning and tolerancing
        2. Dimensioning rules
        3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
    A. Explain positional / location tolerances
    B. Identify and use geometric position tolerancing symbols
        1. Position
        2. Concentricity
        3. Symmetry
III. Explain and Use Tolerances of Form Symbols
    A. Explain form tolerances
    B. Identify and use tolerances of form symbols

        1. Straightness
        2. Flatness
        3. Circularity
        4. Cylindrical

IV. Explain and Use Profile Tolerances
    A. Explain profile tolerance
    B. Identify and use profile tolerance symbols
        1. Profile of a line
        2. Profile of a surface
        3. Profile of an arc
        4. Profile of irregular curves
        5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
    A. Explain orientation tolerances
    B. Identify and use orientation tolerance symbols
        1. Parallelism
        2. Perpendicularity
        3. Angularity

VI. Explain and Use Runout Tolerances
    A. Explain runouts
        1. Circular
        2. Total
    B. Identify and use runout tolerances symbols
        1. Circular
        2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    A. Maximum Material Condition (MMC)
    B. Regardless of Feature Size (RFS)
    C. Least Material Condition (LMC)
    D. Datum feature symbol
    E. Datum reference frame concept
        1. Primary datum plane
        2. Secondary datum plane
        3. Tertiary datum plane
    F. Datum target symbol
        1. Target point
        2. Target line
        3. Target area

VIII. Explain and Use the Feature Control Frame
    A. Explain feature control frame
    B. Explain the compartments of a feature control frame
        1. Geometric characteristic symbol
        2. Geometric tolerance
        3. Zone descriptor
        4. Material condition symbol

        5. Primary datum reference
        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WLD-H14-HO1
Describe the Use of Jigs and Fixtures in Layout and Fit-Up
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand the use of fixtures and jigs for assembly and accuracy.

MODULE OUTLINE:

Instructional Topics:

A. Review the use of jigs and fixtures in layout and fitup
B. Use of clamps and holding devices for correct alignment
C. Placement of tack welds

Student Activities:

A. Use clamps and holding devices to properly align parts to be welded
B. Weld or prepare a fixture for production welding

WLD-H14-HO2

Describe the Use of Jigs and Fixtures in Layout and Fit-Up

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning
        3. Placement of dimensions

4. Choice of dimensions
5. Types of lines used in the dimensioning process
6. Arrowheads used on drawings
7. Leaders used on drawings
8. Dimensioning systems
    a. Fractional
    b. Decimal
    c. Metric
    d. Combination dimensioning
9. Dimension figures
10. Direction of dimension figures
    a. Unidirectional system
    b. Aligned system
11. Dimensioning angles
12. Dimensioning arcs
13. Dimensioning fillets and rounds
14. Identify surfaces to be machined
15. Contour dimensioning
16. Dimensioning of curves
17. Dimensioning of rounded-end shapes
18. Dimensioning of threads
19. Dimensioning of tapers
20. Dimensioning of chamfers
21. Dimensioning shaft centers
22. Dimensioning keyways
23. Dimensioning knurls
    a. Diamond
    b. Straight
24. Dimensioning along curved surfaces
25. Tabular dimensions
26. Dimensioning standards
27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

- B. Methods of expressing tolerances
    - 1. General tolerances
    - 2. Limit dimensioning
    - 3. Plus and minus dimensioning
        - a. Unilateral system
        - b. Bilateral system
    - 4. Single-limit dimensioning
    - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
    - 1. Clearance fit
    - 2. Interference fit
    - 3. Transition fit
    - 4. Line fit
- B. Limits and fits for cylindrical parts
    - 1. Running or sliding clearance fits
    - 2. Locational clearance fits
    - 3. Transition clearance interference fits
    - 4. Locational interference fits
    - 5. Force or shrink fits

WLD-H14-HO3
Describe the Use of Jigs and Fixtures in Layout and Fit-Up
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Distinguish between conventional and geometric dimensioning and tolerancing;
- b. Explain and use geometric positional tolerancing and symbols;
- c. Explain and use tolerances of form and symbols;
- d. Explain and use the feature control symbol; and,
- e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

- I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
    - A. General/conventional tolerancing
        - 1. Definitions of general/conventional tolerancing
            - a. Dimension
            - b. Reference dimension
            - c. Feature
            - d. Feature of size
            - e. Actual size
            - f. Stock size
        - 2. Maximum material condition
        - 3. Least material condition
        - 4. Basic fits
        - 5. Clearance fit
        - 6. Allowance
        - 7. Clearance
        - 8. Force fit
    - B. Geometric dimensioning and tolerancing
        - 1. Definition of geometric dimensioning and tolerancing
        - 2. Dimensioning rules
        - 3. Dimensioning units
- II. Explain and Use Geometric Positional Tolerancing and Symbols
    - A. Explain positional / location tolerances
    - B. Identify and use geometric position tolerancing symbols
        - 1. Position
        - 2. Concentricity
        - 3. Symmetry
- III. Explain and Use Tolerances of Form Symbols
    - A. Explain form tolerances
    - B. Identify and use tolerances of form symbols

1. Straightness
2. Flatness
3. Circularity
4. Cylindrical

IV. Explain and Use Profile Tolerances
  A. Explain profile tolerance
  B. Identify and use profile tolerance symbols
    1. Profile of a line
    2. Profile of a surface
    3. Profile of an arc
    4. Profile of irregular curves
    5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
  A. Explain orientation tolerances
  B. Identify and use orientation tolerance symbols
    1. Parallelism
    2. Perpendicularity
    3. Angularity

VI. Explain and Use Runout Tolerances
  A. Explain runouts
    1. Circular
    2. Total
  B. Identify and use runout tolerances symbols
    1. Circular
    2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  A. Maximum Material Condition (MMC)
  B. Regardless of Feature Size (RFS)
  C. Least Material Condition (LMC)
  D. Datum feature symbol
  E. Datum reference frame concept
    1. Primary datum plane
    2. Secondary datum plane
    3. Tertiary datum plane
  F. Datum target symbol
    1. Target point
    2. Target line
    3. Target area

VIII. Explain and Use the Feature Control Frame
  A. Explain feature control frame
  B. Explain the compartments of a feature control frame
    1. Geometric characteristic symbol
    2. Geometric tolerance
    3. Zone descriptor
    4. Material condition symbol

5. Primary datum reference
6. Secondary datum reference
7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

A. Explain and use additional modifying symbols

1. Diameter
2. Radius R
3. Reference ( )
4. Counterbore/spotface L/
5. Square
6. Dimension origin O
7. Slope
8. Projected tolerance zone
9. Spherical diameter
10. Spherical radius
11. Arc length
12. Counter sink
13. Depth
14. Conical taper
15. Place, times, or by
16. Basic dimension

WLD-H15-HO1

List the Steps to be Followed When Planning a Job

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand job lists for materials; and,

B. Understand work orders and sequence of work.

MODULE OUTLINE:

Instructional Topics:

A. Review the steps in job planning

B. Demonstrate how to select materials based upon drawing specifications

C. How to source and obtain prices for the materials

D. How to use sourcebooks and vendor information for availability and price

E. How to use modern systems for job orders and tracking of raw materials

F. How to deliver the work, close out the job, and bill for payment

Student Activities:

A. Prepare a project summary worksheet to track the progress and cost of the project

WLD-H15-HO2
List the Steps to be Followed When Planning a Job
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
  A. General notes
  B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
  A. General notes applied
    1. Title strip/title block
    2. Parts list/bill of material
  B. Interpret general notes
    1. Including material
    2. General tolerances
    3. Heat treatment
    4. Pattern information
    5. Processes of manufacture
    6. Requirements of the product
  C. Interpret specific notes
    1. Apply to specific operations
    2. Apply to specific processes of manufacture
    3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
  A. Identify organizations that determine dimension standards
    1. American National Standards Institutes (ANSI)
    2. International Standards Organization (ISO)
  B. Determine dimensions on a drawing
    1. Size dimensions
    2. Location dimensions
  C. Applying dimensions on a drawing
    1. Scale of drawing
    2. Techniques of dimensioning
    3. Placement of dimensions

    4. Choice of dimensions
    5. Types of lines used in the dimensioning process
    6. Arrowheads used on drawings
    7. Leaders used on drawings
    8. Dimensioning systems
        a. Fractional
        b. Decimal
        c. Metric
        d. Combination dimensioning
    9. Dimension figures
    10. Direction of dimension figures
        a. Unidirectional system
        b. Aligned system
    11. Dimensioning angles
    12. Dimensioning arcs
    13. Dimensioning fillets and rounds
    14. Identify surfaces to be machined
    15. Contour dimensioning
    16. Dimensioning of curves
    17. Dimensioning of rounded-end shapes
    18. Dimensioning of threads
    19. Dimensioning of tapers
    20. Dimensioning of chamfers
    21. Dimensioning shaft centers
    22. Dimensioning keyways
    23. Dimensioning knurls
        a. Diamond
        b. Straight
    24. Dimensioning along curved surfaces
    25. Tabular dimensions
    26. Dimensioning standards
    27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
  A. Traditional terms used to describe various shapes, processes, and sizes
  B. Identify abbreviations used to describe various shapes, processes, and size
  C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
  A. Identify tolerances or limits
    1. Nominal size
    2. Basic size or dimension
    3. Actual size
    4. Tolerance
    5. Limits
    6. Allowance

- B. Methods of expressing tolerances
    - 1. General tolerances
    - 2. Limit dimensioning
    - 3. Plus and minus dimensioning
        - a. Unilateral system
        - b. Bilateral system
    - 4. Single-limit dimensioning
    - 5. Angular tolerances

VI. Identify ANSI Limits and Fits

- A. Fits between mating parts
    - 1. Clearance fit
    - 2. Interference fit
    - 3. Transition fit
    - 4. Line fit
- B. Limits and fits for cylindrical parts
    - 1. Running or sliding clearance fits
    - 2. Locational clearance fits
    - 3. Transition clearance interference fits
    - 4. Locational interference fits
    - 5. Force or shrink fits

WLD-H15-HO3
List the Steps to be Followed When Planning a Job
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
    A. General/conventional tolerancing
        1. Definitions of general/conventional tolerancing
            a. Dimension
            b. Reference dimension
            c. Feature
            d. Feature of size
            e. Actual size
            f. Stock size
        2. Maximum material condition
        3. Least material condition
        4. Basic fits
        5. Clearance fit
        6. Allowance
        7. Clearance
        8. Force fit
    B. Geometric dimensioning and tolerancing
        1. Definition of geometric dimensioning and tolerancing
        2. Dimensioning rules
        3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
    A. Explain positional / location tolerances
    B. Identify and use geometric position tolerancing symbols
        1. Position
        2. Concentricity
        3. Symmetry
III. Explain and Use Tolerances of Form Symbols
    A. Explain form tolerances
    B. Identify and use tolerances of form symbols

    - 1. Straightness
    - 2. Flatness
    - 3. Circularity
    - 4. Cylindrical
- IV. Explain and Use Profile Tolerances
  - A. Explain profile tolerance
  - B. Identify and use profile tolerance symbols
    - 1. Profile of a line
    - 2. Profile of a surface
    - 3. Profile of an arc
    - 4. Profile of irregular curves
    - 5. Profile of coplanar surfaces
- V. Explain and Use Tolerances of Orientation
  - A. Explain orientation tolerances
  - B. Identify and use orientation tolerance symbols
    - 1. Parallelism
    - 2. Perpendicularity
    - 3. Angularity
- VI. Explain and Use Runout Tolerances
  - A. Explain runouts
    - 1. Circular
    - 2. Total
  - B. Identify and use runout tolerances symbols
    - 1. Circular
    - 2. Total
- VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
  - A. Maximum Material Condition (MMC)
  - B. Regardless of Feature Size (RFS)
  - C. Least Material Condition (LMC)
  - D. Datum feature symbol
  - E. Datum reference frame concept
    - 1. Primary datum plane
    - 2. Secondary datum plane
    - 3. Tertiary datum plane
  - F. Datum target symbol
    - 1. Target point
    - 2. Target line
    - 3. Target area
- VIII. Explain and Use the Feature Control Frame
  - A. Explain feature control frame
  - B. Explain the compartments of a feature control frame
    - 1. Geometric characteristic symbol
    - 2. Geometric tolerance
    - 3. Zone descriptor
    - 4. Material condition symbol

        5. Primary datum reference
        6. Secondary datum reference
        7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

    A. Explain and use additional modifying symbols.
        1. Diameter
        2. Radius R
        3. Reference ( )
        4. Counterbore/spotface L/
        5. Square
        6. Dimension origin O
        7. Slope
        8. Projected tolerance zone
        9. Spherical diameter
        10. Spherical radius
        11. Arc length
        12. Counter sink
        13. Depth
        14. Conical taper
        15. Place, times, or by
        16. Basic dimension

WLD-H16-HO1
Interpret Structural Detail Sheets
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to use detail drawings and structural details

---

MODULE OUTLINE:

Instructional Topics:

A. Detail drawings as compared to the general engineering drawing
B. Dimensions needed for construction
C. Directions, as may be indicated by notes and symbols for the work required
D. The assembly print, showing the complete and assembled item, with relationships
E. Subassembly prints, which assist as preparation of the bill of materials
F. General structural shape and size specifications

Student Activities:

A. Use subassembly prints to prepare bill of materials
B. Practice size specifications with assigned structural shapes

WLD-H16-HO2

Interpret Structural Detail Sheets

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

MODULE OUTLINE:

I. Distinguish Between General and Specific Notes
    A. General notes
    B. Specific notes/local notes
II. Interpret and Apply General and Specific Notes
    A. General notes applied
        1. Title strip/title block
        2. Parts list/bill of material
    B. Interpret general notes
        1. Including material
        2. General tolerances
        3. Heat treatment
        4. Pattern information
        5. Processes of manufacture
        6. Requirements of the product
    C. Interpret specific notes
        1. Apply to specific operations
        2. Apply to specific processes of manufacture
        3. Apply to the requirements of the product
III. Determine and Apply Dimensions on a Drawing
    A. Identify organizations that determine dimension standards
        1. American National Standards Institutes (ANSI)
        2. International Standards Organization (ISO)
    B. Determine dimensions on a drawing
        1. Size dimensions
        2. Location dimensions
    C. Applying dimensions on a drawing
        1. Scale of drawing
        2. Techniques of dimensioning
        3. Placement of dimensions

        4. Choice of dimensions
        5. Types of lines used in the dimensioning process
        6. Arrowheads used on drawings
        7. Leaders used on drawings
        8. Dimensioning systems
            a. Fractional
            b. Decimal
            c. Metric
            d. Combination dimensioning
        9. Dimension figures
        10. Direction of dimension figures
            a. Unidirectional system
            b. Aligned system
        11. Dimensioning angles
        12. Dimensioning arcs
        13. Dimensioning fillets and rounds
        14. Identify surfaces to be machined
        15. Contour dimensioning
        16. Dimensioning of curves
        17. Dimensioning of rounded-end shapes
        18. Dimensioning of threads
        19. Dimensioning of tapers
        20. Dimensioning of chamfers
        21. Dimensioning shaft centers
        22. Dimensioning keyways
        23. Dimensioning knurls
            a. Diamond
            b. Straight
        24. Dimensioning along curved surfaces
        25. Tabular dimensions
        26. Dimensioning standards
        27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
    A. Traditional terms used to describe various shapes, processes, and sizes
    B. Identify abbreviations used to describe various shapes, processes, and size
    C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
    A. Identify tolerances or limits
        1. Nominal size
        2. Basic size or dimension
        3. Actual size
        4. Tolerance
        5. Limits
        6. Allowance

B. Methods of expressing tolerances
    1. General tolerances
    2. Limit dimensioning
    3. Plus and minus dimensioning
        a. Unilateral system
        b. Bilateral system
    4. Single-limit dimensioning
    5. Angular tolerances

VI. Identify ANSI Limits and Fits
    A. Fits between mating parts
        1. Clearance fit
        2. Interference fit
        3. Transition fit
        4. Line fit
    B. Limits and fits for cylindrical parts
        1. Running or sliding clearance fits
        2. Locational clearance fits
        3. Transition clearance interference fits
        4. Locational interference fits
        5. Force or shrink fits

WLD-H16-HO3
Interpret Structural Detail Sheets
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

MODULE OUTLINE:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
    A. General/conventional tolerancing
        1. Definitions of general/conventional tolerancing
            a. Dimension
            b. Reference dimension
            c. Feature
            d. Feature of size
            e. Actual size
            f. Stock size
        2. Maximum material condition
        3. Least material condition
        4. Basic fits
        5. Clearance fit
        6. Allowance
        7. Clearance
        8. Force fit
    B. Geometric dimensioning and tolerancing
        1. Definition of geometric dimensioning and tolerancing
        2. Dimensioning rules
        3. Dimensioning units
II. Explain and Use Geometric Positional Tolerancing and Symbols
    A. Explain positional / location tolerances
    B. Identify and use geometric position tolerancing symbols
        1. Position
        2. Concentricity
        3. Symmetry
III. Explain and Use Tolerances of Form Symbols
    A. Explain form tolerances
    B. Identify and use tolerances of form symbols

        1. Straightness
        2. Flatness
        3. Circularity
        4. Cylindrical

IV. Explain and Use Profile Tolerances
    A. Explain profile tolerance
    B. Identify and use profile tolerance symbols
        1. Profile of a line
        2. Profile of a surface
        3. Profile of an arc
        4. Profile of irregular curves
        5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
    A. Explain orientation tolerances
    B. Identify and use orientation tolerance symbols
        1. Parallelism
        2. Perpendicularity
        3. Angularity

VI. Explain and Use Runout Tolerances
    A. Explain runouts
        1. Circular
        2. Total
    B. Identify and use runout tolerances symbols
        1. Circular
        2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
    A. Maximum Material Condition (MMC)
    B. Regardless of Feature Size (RFS)
    C. Least Material Condition (LMC)
    D. Datum feature symbol
    E. Datum reference frame concept
        1. Primary datum plane
        2. Secondary datum plane
        3. Tertiary datum plane
    F. Datum target symbol
        1. Target point
        2. Target line
        3. Target area

VIII. Explain and Use the Feature Control Frame
    A. Explain feature control frame
    B. Explain the compartments of a feature control frame
        1. Geometric characteristic symbol
        2. Geometric tolerance
        3. Zone descriptor
        4. Material condition symbol

5. Primary datum reference
6. Secondary datum reference
7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols

A. Explain and use additional modifying symbols.
   1. Diameter
   2. Radius R
   3. Reference ( )
   4. Counterbore/spotface L/
   5. Square
   6. Dimension origin O
   7. Slope
   8. Projected tolerance zone
   9. Spherical diameter
   10. Spherical radius
   11. Arc length
   12. Counter sink
   13. Depth
   14. Conical taper
   15. Place, times, or by
   16. Basic dimension

WLD-H17-HO
Describe Methods for Straightening and Removing Damaged Structural and Machinery Parts
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand heat expansion of metal; and,

B. Understand methods for structural repairs.

MODULE OUTLINE:

Instructional Topics:

A. Metal properties and methods of repair

B. Types of structural damage that can usually not be repaired

C. Inspection and test of repaired items

D. Common machine repairs and testing of outcomes

Student Activities:

A. Use cutting methods for assigned removal of damaged parts

B. Use welding methods for assigned repairs of machinery

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric-English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their efforts on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 Perform GMAW [illegible] T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat, horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

Duty I

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-I1-HO
Gather Materials for the Job
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate the ability to list to list material requirements from drawings, sketches and specification package;

B. Understand how to identify material requirements from a material list; and,

C. Select the material from information given by drawings, sketches and specification packages.

MODULE OUTLINE:

Instructional Topics:

A. Illustrate how to determine the blueprints material requirements

B. Demonstrate effective techniques on the choice weld process and equipment to be used

C. Illustrate proper procedure to set up a weld station

D. Sources of information for compatible alloys for base metal, filler metal, electrodes, or appropriate materials for the job

E. Demonstrate how to set-up a safe work environment

F. Demonstrate layout of work table and tools

Student Activities:

A. Gather and assemble raw materials, preparing for the job specified in the engineering drawing or other job instructions

B. Begin the process of setting up equipment and welding apparatus appropriate to the job

C. Layout work table and tools in a safe and efficient manner

WLD-I2-HO
Gather Welding Equipment and Tools
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform initial safety inspection of equipment and accessories;
B. Make minor external repairs or adjustments to equipment and accessories;
C. Understand related terms and definitions; and,
D. Identify the necessary tools to perform specific tasks.

MODULE OUTLINE:

Instructional Topics:

A. Proper selection procedures for welding tools and equipment
B. Schedule availability of tools and equipment for the duration of the job
C. Demonstrate effective techniques on the choice of equipment to be used
D. Demonstrate set-up, operate, and shut down procedures
E. Demonstrate a post production weld process
F. Plan for use testing techniques set by the American Welding Society or specified by the customer
G. Demonstrate how to perform layout to insure safe working conditions
H. Explain the fundamental characteristics of AC and DC current and how this applies to welding and cutting devices

Student Activities:

A. Identify the importance of safety unique to each type of welding
B. Practice job planning and determine equipment needs for the duration of job operations
C. Make minor repairs under supervision of instructor

WLD-I3-HO
Check Welding Equipment for Safety
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand safety in welding and cutting (ANSI/ASC Z49.1);
B. Perform work area inspection;
C. Identify safety hazards; and,
D. Perform minor repairs to equipment to insure safety in operations.

MODULE OUTLINE:

Instructional Topics:

A. Illustrate proper procedure to set up a weld station
B. Demonstrate effective techniques on the choice of weld process equipment to be used
C. Practice safety in welding and cutting (ANSI/ASC Z49.1)
D. Demonstrate set-up, operate, and shut down procedures
E. Demonstrate a post production weld process
F. Use testing techniques set by the American Welding Society
G. Demonstrate how to maintain a safe work environment

Student Activities:

A.. Identify the importance of safety unique to each type of welding
B. Perform work area inspection
C. Identify safety hazards
D. Remove flammable materials from the welding area
E. Assemble required accessories and safety equipment (fire extinguishers, curtains and shields, and special protective clothing)
F. Position welding apparatus or machine

WLD-I4-HO
Set-Up Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Review ANSI Z49.1, "Safety in Welding and Cutting Allied Processes", Part II specific processes, II. Arc Welding and Cutting Equipment Safety;
B. Perform safety inspection of work area and equipment;
C. Position welding apparatus or machine;
D. Check position of work for welding;
E. Check and adjust controls for apparatus and machines; and,
F. Understand gas bottle storage and ventilation requirements.

MODULE OUTLINE:

Instructional Topics:

A. Illustrate proper procedures to select weld process and to set up a weld station
B. Demonstrate effective techniques in inspection of equipment to be used
C. Plan set-up, operate, and shut down procedures
D. Practice initial welding set up operations and shut-down procedures
E. Review of compatible alloys for processes to be practiced
F. Demonstrate how to set-up a safe work environment

Student Activities:

A. Identify the importance of safety unique to each type of welding
B. Use of safety equipment and personal protective equipment
C. Set up individual welding machine
D. Make safe power on settings and adjustments on welding machine as necessary
E. Perform pre-production weld to assure proper adjustment
F. Practice selection and handling of electrodes, filler metals, hoses, cables, tips, holders, and other materials used in the demonstration process

WLD-I5-HO
Make Test-Weld to Verify Parameters
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand welding equipment and principles of operation;
B. Perform weld to set parameters; and,
C. Make adjustments on equipment for a maximum quality weld.

MODULE OUTLINE:

Instructional Topics:

A. Illustrate proper procedure to set up a weld station
B. Demonstrate effective techniques on the choice of equipment to be used
C. Demonstrate set-up, operate, and shut down procedures
D. Demonstrate the usability of the planned production weld process
E. Use testing techniques set by the American Welding Society or customer specification
F. Illustrate how to determine the blueprints material requirements
G. Review of compatible alloys, filler metals, electrodes (as appropriate)
H. Demonstrate how to set-up and maintain a safe work environment
I. Demonstrate a fundamental knowledge of AC and DC current and how it applies to welding and cutting devices

Student Activities:

A. Identify the importance of safety unique to each type of welding
B. Set up individual welding apparatus or machine
C. Make adjustments to welding apparatus or machine as necessary
D. Perform pre-production weld to assure proper adjustment

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

	Duties	← Tasks →												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purposes and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and [illegible] welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

2440

2450

Duty J

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties ← **Tasks** →

M2 GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3 GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required; understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1 Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2 Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-J1-HO1
Prepare Joint Geometry Using Mechanical Method
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand groove angle must be large enough to permit proper manipulation of the filler metal and deposition of stringer or weave weld beads;

B. Understand the many factors that influence joint design; and,

C. Understand the most common design adjustment is to locate the welded joints in regions of known low stress.

MODULE OUTLINE:

Instructor Topic:

A. Identify clean welding surfaces

B. Demonstrate adequate cleaning techniques on various metals

C. Illustrate how to assemble weld joints

D. Use measurement devices to check weld opening or verify setup

E. Illustrate proper tacking of a part

F. Utilize visuals for instruction emphasis

G. Illustrate how to identify impurities on parent metal

H. Demonstrate the purge process on specialty metals

I. Explain the use of chemicals for cleaning and preparing metals

J. Explain the use of particles for cleaning metal

Student Activities:

A. Study joint design using AWS standards

B. Clean weld area using wire brush

C. Tack together test plates and practice plates

D. Check the gap size in practice and test plates

E. Clean weld area using grinders and files

WLD-J1-HO2

Prepare Joint Geometry Using Mechanical Method

Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss classification system for metals; and,

b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals.

MODULE OUTLINE:

I. Discuss the Physical Properties of Metal
  - A. Brittleness - the property of a metal which permits no permanent distortion before breaking
  - B. Ductility - the ability of the metal to be permanently deformed without breaking
  - C. Elasticity - the ability of a metal to return to its original shape after any force acting upon it has been removed
  - D. Hardness - the resistance to forcible penetration
  - E. Malleability - the property of a metal which permits it to be hammered or rolled into other sizes and shapes
  - F. Tensile strength - the maximum amount of pull that a material will withstand before breaking
  - G. Toughness - the property of a metal to withstand shock or impact

II. Discuss the Classification System for Steel
  - A. Carbon steels
    - 1. Low carbon steel - contains from 0.02 to 0.20 percent of carbon
    - 2. Medium carbon steel - contains from 0.30 to 0.60 percent of carbon
    - 3. High carbon steel (tool steel) - contains over 0.60 percent of carbon
  - B. Alloy steels - alloying elements allow steels to possess special characteristics
    Discuss Table 1.1 "Effects of Alloying Elements on Steel"
    Discuss Table 1.2 "SAE-ANSI Numerical Designation of Alloy Steels"

III. Describe General Characteristics For:
  - A. Carbon Steels
  - B. Tool Steels
  - C. Stainless Steels
  - D. Structural Steels
  - E. Cast Irons
  - F. Non-Ferrous Metals
    - 1. Aluminum and Its Alloys
    - 2. Copper and Its Alloys
    - 3. Nickel Alloys
    - 4. Precious Metals
    - 5. Others

WLD-J1-HO3

Prepare Joint Geometry Using Mechanical Method

Attachment 3: **MASTER** Handout No. 3

TABLES FOR PROPERTIES OF METALS

TABLE 1.1

THE EFFECT OF ALLOYING ELEMENTS ON STEEL

EFFECT	ELEMENT											
	Carbon	Chromium	Cobalt	Lead	Manganese	Molybdenum	Nickel	Phosphorus	Silicon	Sulfur	Tungsten	Vanadium
Increases tensile strength	X	X			X	X	X					
Increases hardness	X	X										
Increases wear resistance	X	X			X		X				X	
Increases hardenability	X	X			X	X	X					X
Increases ductility					X							
Increases elastic limit		X				X						
Increases rust resistance		X					X					
Increases abrasion resistance		X			X							
Increases toughness		X				X	X					X
Increases shock resistance		X					X					X
Increases fatigue resistance												X
Decreases ductility	X	X										
Decreases toughness			X									
Raises critical temperature		X	X								X	
Lowers critical temperature					X		X					
Causes hot shortness										X		
Causes cold shortness								X				
Imparts red hardness			X			X					X	
Imparts fine grain structure					X							X
Reduces deformation					X		X					
Acts as deoxidizer					X				X			
Acts as desulphurizer					X							
Imparts oil hardening properties		X			X	X	X					
Imparts air hardening properties					X	X						
Eliminates blow holes								X				
Creates soundness in casting									X			
Facilitates rolling and forging					X				X			
Improves machinability				X						X		

WLD-J1-HO4
Prepare Joint Geometry Using Mechanical Method
Attachment 4: **MASTER** Handout No. 4

TABLE 1.2

SAE-AISI NUMERICAL DESIGNATION OF ALLOY STEELS
(X Represents Percent of Carbon in Hundredths)

Carbon Steels	
Plain carbon	10xx
Free-cutting, resulfurized	11xx
Manganese Steels	13xx
Nickel Steels	
.50% nickel	20xx
1.50% nickel	21xx
3.50% nickel	23xx
5.00% nickel	25xx
Nickel-Chromium Steels	
1.25% nickel, .65% chromium	31xx
1.75% nickel, 1.00% chromium	32xx
3.50% nickel, 1.57% chromium	33xx
3.00% nickel, .80% chromium	34xx
Corrosion and heat-resisting steels	303xx
Molybdenum Steels	
Chromium	41xx
Chromium-nickel	43xx
Nickel	46xx and 48xx
Chromium Steels	
Low-chromium	50xx
Medium-chromium	511xx
High-chromium	521xx
Chromium-Vanadium Steels	6xxx
Tungsten Steels	7xxx and 7xxxx
Triple-Alloy Steels	8xxx
Silicon-Manganese Steels	9xxx
Leaded steels	11Lxx (example)

WLD-J1-HO5
Prepare Joint Geometry Using Mechanical Method
Attachment 5: **MASTER** Handout No. 5

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Briefly describe and list the advantages and disadvantages for each of the following: casting processes, hot working processes, and cold working processes;
b. Discuss service requirements (strength, hardness, etc.);
c. Discuss fastening processes (fasteners, welding, bonding, etc.); and,
d. Discuss corrosion resistance methods.

MODULE OUTLINE:

I. Describe Casting Processes
  A. Discuss the following casting processes: sand, evaporative, shell molding, permanent mold, centrifugal, investment, and die casting
  B. Discuss pattern and mold design factors for each of the above casting processes
  C. List the advantages and disadvantages of the casting processes
II. Describe Hot Working Processes
  A. Discuss the following hot working processes: rolling, strand casting, forging, drawing, extrusion, spinning, and roll forming
  B. List the advantages and disadvantages of the hot working processes
III. Describe Cold Working Processes
  A. Discuss the following cold working processes: rolling, blanking, pressing, drawing, extruding, wire and bar drawing, bending, shearing, and roll forming
  B. List the advantages and disadvantages of the cold working process
IV. Evaluate Alternative Manufacturing Processes
  A. Discuss the powder metallurgy process (PM)
  B. Discuss the following nontraditional machining processes: EDM, laser machining, ultrasonic machining, hydrojet machining, electron beam machining, and plasma beam machining

WLD-J2-HO1
Clean Weld Area
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand surface preparation;
B. Determine specifications for weld appearance; and,
C. Prepare surfaces appropriate to the type joint design and strength requirement.

MODULE OUTLINE:

Instructor Topic:

A. Identify clean welding surfaces
B. Demonstrate adequate cleaning techniques for various metals
C. Demonstrate use of iron-powder electrodes and automatic welding, minimizing spatter and roughness
D. Removal of moisture
E. Eliminate organic contaminants
F. Remove oxide films left by flame beveling and machining
G. Avoid metal contamination from brushes or tools
H. Demonstrate the purge process on specialty metals
I. Explain the use of chemicals for cleaning and preparing metals
J. Explain the use of particles for cleaning metal

Student Activities:

A. Review joint design using AWS standards
B. Check the gap size in practice and test plates
C. Clean weld area grinders, chemicals, and files
D. Minimize spatter with weld techniques

WLD-J2-HO2
Clean Weld Area
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss classification system for metals; and,
b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals.

MODULE OUTLINE:

I. Discuss the Physical Properties of Metal
  A. Brittleness - the property of a metal which permits no permanent distortion before breaking
  B. Ductility - the ability of the metal to be permanently deformed without breaking
  C. Elasticity - the ability of a metal to return to its original shape after any force acting upon it has been removed
  D. Hardness - the resistance to forcible penetration
  E. Malleability - the property of a metal which permits it to be hammered or rolled into other sizes and shapes
  F. Tensile strength - the maximum amount of pull that a material will withstand before breaking
  G. Toughness - the property of a metal to withstand shock or impact
II. Discuss the Classification System for Steel
  A. Carbon steels
    1. Low carbon steel - contains from 0.02 to 0.20 percent of carbon
    2. Medium carbon steel - contains from 0.30 to 0.60 percent of carbon
    3. High carbon steel (tool steel) - contains over 0.60 percent of carbon
  B. Alloy steels - alloying elements allow steels to possess special characteristics
  Discuss Table 1.1 "Effects of Alloying Elements on Steel"
  Discuss Table 1.2 "SAE-ANSI Numerical Designation of Alloy Steels"
III. Describe General Characteristics For:
  A. Carbon Steels
  B. Tool Steels
  C. Stainless Steels
  D. Structural Steels
  E. Cast Irons
  F. Non-Ferrous Metals
    1. Aluminum and Its Alloys
    2. Copper and Its Alloys
    3. Nickel Alloys
    4. Precious Metals
    5. Others

TABLES FOR PROPERTIES OF METALS
TABLE 1.1

THE EFFECT OF ALLOYING ELEMENTS ON STEEL

EFFECT	ELEMENT											
	Carbon	Chromium	Cobalt	Lead	Manganese	Molybdenum	Nickel	Phosphorus	Silicon	Sulfur	Tungsten	Vanadium
Increases tensile strength	X	X			X	X	X					
Increases hardness	X	X										
Increases wear resistance	X	X			X		X				X	
Increases hardenability	X	X			X	X	X					X
Increases ductility					X							
Increases elastic limit		X				X						
Increases rust resistance		X					X					
Increases abrasion resistance		X			X							
Increases toughness		X				X	X					X
Increases shock resistance		X					X					X
Increases fatigue resistance												X
Decreases ductility	X	X										
Decreases toughness			X									
Raises critical temperature		X	X								X	
Lowers critical temperature					X		X					
Causes hot shortness										X		
Causes cold shortness								X				
Imparts red hardness			X			X					X	
Imparts fine grain structure					X							X
Reduces deformation					X		X					
Acts as deoxidizer					X				X			
Acts as desulphurizer					X							
Imparts oil hardening properties		X			X	X	X					
Imparts air hardening properties					X	X						
Eliminates blow holes								X				
Creates soundness in casting									X			
Facilitates rolling and forging					X				X			
Improves machinability				X						X		

TABLE 1.2

SAE-AISI NUMERICAL DESIGNATION OF ALLOY STEELS
(X Represents Percent of Carbon in Hundredths)

Carbon Steels	
Plain carbon	10xx
Free-cutting, resulfurized	11xx
Manganese Steels	13xx
Nickel Steels	
.50% nickel	20xx
1.50% nickel	21xx
3.50% nickel	23xx
5.00% nickel	25xx
Nickel-Chromium Steels	
1.25% nickel, .65% chromium	31xx
1.75% nickel, 1.00% chromium	32xx
3.50% nickel, 1.57% chromium	33xx
3.00% nickel, .80% chromium	34xx
Corrosion and heat-resisting steels	303xx
Molybdenum Steels	
Chromium	41xx
Chromium-nickel	43xx
Nickel	46xx and 48xx
Chromium Steels	
Low-chromium	50xx
Medium-chromium	511xx
High-chromium	521xx
Chromium-Vanadium Steels	6xxx
Tungsten Steels	7xxx and 7xxxx
Triple-Alloy Steels	8xxx
Silicon-Manganese Steels	9xxx
Leaded steels	11Lxx (example)

WLD-J2-HO5
Clean Weld Area
Attachment 5: **MASTER** Handout No. 5

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- a. Briefly describe and list the advantages and disadvantages for each of the following: casting processes, hot working processes, and cold working processes;
- b. Discuss service requirements (strength, hardness, etc.);
- c. Discuss fastening processes (fasteners, welding, bonding, etc.); and,
- d. Discuss corrosion resistance methods.

MODULE OUTLINE:
- I. Describe Casting Processes
  - A. Discuss the following casting processes: sand, evaporative, shell molding, permanent mold, centrifugal, investment, and die casting
  - B. Discuss pattern and mold design factors for each of the above casting processes
  - C. List the advantages and disadvantages of the casting processes
- II. Describe Hot Working Processes
  - A. Discuss the following hot working processes: rolling, strand casting, forging, drawing, extrusion, spinning, and roll forming
  - B. List the advantages and disadvantages of the hot working processes
- III. Describe Cold Working Processes
  - A. Discuss the following cold working processes: rolling, blanking, pressing, drawing, extruding, wire and bar drawing, bending, shearing, and roll forming
  - B. List the advantages and disadvantages of the cold working process
- IV. Evaluate Alternative Manufacturing Processes
  - A. Discuss the powder metallurgy process (PM)
  - B. Discuss the following nontraditional machining processes: EDM, laser machining, ultrasonic machining, hydrojet machining, electron beam machining, and plasma beam machining

WLD-J3-HO1
Fit-Up Joint
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand fit-up requirements specified;
B. Understand orthographic views;
C. Understand surface to center line relationships;
D. Understand auxiliary views; and,
E. Perform joint preparation and fit-up.

MODULE OUTLINE:

Instructor Topic:

A. Prepare clean welding surfaces
B. Demonstrate adequate cleaning techniques on various metals
C. Perform spacing, alignment, and arrangement of joint edges
D. Illustrate how to assemble weld joints
E. Use of vise, clamps, braces or special jigs for alignment
F. Use measurement devices to check weld opening or verify fit-up
G. Cleaning joint edges and surfaces
H. Cutting bevels for grooves by machining, grinding, or gas flame cutting
I. Illustrate proper tacking of a part
J. Explain shape, size, and dimensional considerations
K. Explain the use of chemicals for cleaning and preparing metals
L. Explain the use of particles for cleaning metal

Student Activities:

A. Study joint design using AWS standards
B. Clean weld area using recommended method
C. Tack together test plates and practice plates
D. Check the gap size in practice and test plates
E. Clean weld area using chemicals, grinders and files, and other methods as appropriate

WLD-J3-HO2
Fit-Up Joint
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss classification system for metals; and,
b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals.

MODULE OUTLINE:

I. Discuss the Physical Properties of Metal
  A. Brittleness - the property of a metal which permits no permanent distortion before breaking
  B. Ductility - the ability of the metal to be permanently deformed without breaking
  C. Elasticity - the ability of a metal to return to its original shape after any force acting upon it has been removed
  D. Hardness - the resistance to forcible penetration
  E. Malleability - the property of a metal which permits it to be hammered or rolled into other sizes and shapes
  F. Tensile strength - the maximum amount of pull that a material will withstand before breaking
  G. Toughness - the property of a metal to withstand shock or impact
II. Discuss the Classification System for Steel
  A. Carbon steels
    1. Low carbon steel - contains from 0.02 to 0.20 percent of carbon
    2. Medium carbon steel - contains from 0.30 to 0.60 percent of carbon
    3. High carbon steel (tool steel) - contains over 0.60 percent of carbon
  B. Alloy steels - alloying elements allow steels to possess special characteristics
     Discuss Table 1.1 "Effects of Alloying Elements on Steel"
     Discuss Table 1.2 "SAE-ANSI Numerical Designation of Alloy Steels"
III. Describe General Characteristics For:
  A. Carbon Steels
  B. Tool Steels
  C. Stainless Steels
  D. Structural Steels
  E. Cast Irons
  F. Non-Ferrous Metals
    1. Aluminum and Its Alloys
    2. Copper and Its Alloys
    3. Nickel Alloys
    4. Precious Metals
    5. Others

WLD-J3-HO3
Fit-Up Joint
Attachment 3: **MASTER** Handout No. 3

TABLES FOR PROPERTIES OF METALS
TABLE 1.1

THE EFFECT OF ALLOYING ELEMENTS ON STEEL

EFFECT	ELEMENT											
	Carbon	Chromium	Cobalt	Lead	Manganese	Molybdenum	Nickel	Phosphorus	Silicon	Sulfur	Tungsten	Vanadium
Increases tensile strength	X	X			X	X	X					
Increases hardness	X	X										
Increases wear resistance	X	X			X		X				X	
Increases hardenability	X	X			X	X	X					X
Increases ductility					X							
Increases elastic limit		X				X						
Increases rust resistance		X					X					
Increases abrasion resistance		X			X							
Increases toughness		X				X	X					X
Increases shock resistance		X					X					X
Increases fatigue resistance												X
Decreases ductility	X	X										
Decreases toughness			X									
Raises critical temperature		X	X								X	
Lowers critical temperature					X		X					
Causes hot shortness										X		
Causes cold shortness								X				
Imparts red hardness			X			X					X	
Imparts fine grain structure					X							X
Reduces deformation					X		X					
Acts as deoxidizer					X				X			
Acts as desulphurizer					X							
Imparts oil hardening properties		X			X	X	X					
Imparts air hardening properties					X	X						
Eliminates blow holes								X				
Creates soundness in casting									X			
Facilitates rolling and forging					X				X			
Improves machinability				X						X		

TABLE 1.2

SAE-AISI NUMERICAL DESIGNATION OF ALLOY STEELS
(X Represents Percent of Carbon in Hundredths)

Carbon Steels	
Plain carbon	10xx
Free-cutting, resulfurized	11xx
Manganese Steels	13xx
Nickel Steels	
.50% nickel	20xx
1.50% nickel	21xx
3.50% nickel	23xx
5.00% nickel	25xx
Nickel-Chromium Steels	
1.25% nickel, .65% chromium	31xx
1.75% nickel, 1.00% chromium	32xx
3.50% nickel, 1.57% chromium	33xx
3.00% nickel, .80% chromium	34xx
Corrosion and heat-resisting steels	303xx
Molybdenum Steels	
Chromium	41xx
Chromium-nickel	43xx
Nickel	46xx and 48xx
Chromium Steels	
Low-chromium	50xx
Medium-chromium	511xx
High-chromium	521xx
Chromium-Vanadium Steels	6xxx
Tungsten Steels	7xxx and 7xxxx
Triple-Alloy Steels	8xxx
Silicon-Manganese Steels	9xxx
Leaded steels	11Lxx (example)

WLD-J3-HO5
Fit-Up Joint
Attachment 5: **MASTER** Handout No. 5

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Briefly describe and list the advantages and disadvantages for each of the following: casting processes, hot working processes, and cold working processes;
- b. Discuss service requirements (strength, hardness, etc.);
- c. Discuss fastening processes (fasteners, welding, bonding, etc.); and,
- d. Discuss corrosion resistance methods.

MODULE OUTLINE:

- I. Describe Casting Processes
  - A. Discuss the following casting processes: sand, evaporative, shell molding, permanent mold, centrifugal, investment, and die casting
  - B. Discuss pattern and mold design factors for each of the above casting processes
  - C. List the advantages and disadvantages of the casting processes
- II. Describe Hot Working Processes
  - A. Discuss the following hot working processes: rolling, strand casting, forging, drawing, extrusion, spinning, and roll forming
  - B. List the advantages and disadvantages of the hot working processes
- III. Describe Cold Working Processes
  - A. Discuss the following cold working processes: rolling, blanking, pressing, drawing, extruding, wire and bar drawing, bending, shearing, and roll forming
  - B. List the advantages and disadvantages of the cold working process
- IV. Evaluate Alternative Manufacturing Processes
  - A. Discuss the powder metallurgy process (PM)
  - B. Discuss the following nontraditional machining processes: EDM, laser machining, ultrasonic machining, hydrojet machining, electron beam machining, and plasma beam machining

WLD-J4-HO1
Verify Joint Preparation
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Use prior modules in sequence with applications;
B. Understand the requirements for joint preparation; and,
C. Inspect the joint preparation.

MODULE OUTLINE:

Instructor Topic:

A. Identify clean welding surfaces
B. Demonstrate adequate cleaning techniques on various metals
C. Illustrate how to assemble weld joints
D. Use measurement devices to check weld opening or verify setup
E. Illustrate proper tacking of a part
F. Explain considerations for economical use of filler metal
G. Explain consideration for base metal type and thickness
H. Demonstrate positions for welding
I. Discuss welding techniques used
J. Discuss type of gases used (as applicable)
K. Demonstrate appropriate power source as having impact upon the weld

Student Activities:

A. Study joint design using AWS guidelines
B. Clean weld area
C. Tack together test plates and practice plates
D. Measure the gap size in practice and test plates
E. Demonstrate understanding of selected welding technique

WLD-J4-HO2
Verify Joint Preparation
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Discuss classification system for metals; and,
- b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals.

MODULE OUTLINE:

- I. Discuss the Physical Properties of Metal
  - A. Brittleness - the property of a metal which permits no permanent distortion before breaking
  - B. Ductility - the ability of the metal to be permanently deformed without breaking
  - C. Elasticity - the ability of a metal to return to its original shape after any force acting upon it has been removed
  - D. Hardness - the resistance to forcible penetration
  - E. Malleability - the property of a metal which permits it to be hammered or rolled into other sizes and shapes
  - F. Tensile strength - the maximum amount of pull that a material will withstand before breaking
  - G. Toughness - the property of a metal to withstand shock or impact
- II. Discuss the Classification System for Steel
  - A. Carbon steels
    - 1. Low carbon steel - contains from 0.02 to 0.20 percent of carbon
    - 2. Medium carbon steel - contains from 0.30 to 0.60 percent of carbon
    - 3. High carbon steel (tool steel) - contains over 0.60 percent of carbon
  - B. Alloy steels - alloying elements allow steels to possess special characteristics
    Discuss Table 1.1 "Effects of Alloying Elements on Steel"
    Discuss Table 1.2 "SAE-ANSI Numerical Designation of Alloy Steels"
- III. Describe General Characteristics For:
  - A. Carbon Steels
  - B. Tool Steels
  - C. Stainless Steels
  - D. Structural Steels
  - E. Cast Irons
  - F. Non-Ferrous Metals
    - 1. Aluminum and Its Alloys
    - 2. Copper and Its Alloys
    - 3. Nickel Alloys
    - 4. Precious Metals
    - 5. Others

WLD-J4-HO3
Verify Joint Preparation
Attachment 3: **MASTER** Handout No. 3

TABLES FOR PROPERTIES OF METALS
TABLE 1.1

THE EFFECT OF ALLOYING ELEMENTS ON STEEL

EFFECT	ELEMENT											
	Carbon	Chromium	Cobalt	Lead	Manganese	Molybdenum	Nickel	Phosphorus	Silicon	Sulfur	Tungsten	Vanadium
Increases tensile strength	X	X			X	X	X					
Increases hardness	X	X										
Increases wear resistance	X	X			X		X				X	
Increases hardenability	X	X			X	X	X					X
Increases ductility					X							
Increases elastic limit		X				X						
Increases rust resistance		X					X					
Increases abrasion resistance		X			X							
Increases toughness		X				X	X					X
Increases shock resistance		X					X					X
Increases fatigue resistance												X
Decreases ductility	X	X										
Decreases toughness			X									
Raises critical temperature		X	X								X	
Lowers critical temperature					X		X					
Causes hot shortness										X		
Causes cold shortness								X				
Imparts red hardness			X			X					X	
Imparts fine grain structure					X							X
Reduces deformation					X		X					
Acts as deoxidizer					X				X			
Acts as desulphurizer					X							
Imparts oil hardening properties		X			X	X	X					
Imparts air hardening properties					X	X						
Eliminates blow holes								X				
Creates soundness in casting									X			
Facilitates rolling and forging					X				X			
Improves machinability				X						X		

TABLE 1.2

SAE-AISI NUMERICAL DESIGNATION OF ALLOY STEELS
(X Represents Percent of Carbon in Hundredths)

Carbon Steels	
Plain carbon	10xx
Free-cutting, resulfurized	11xx
Manganese Steels	13xx
Nickel Steels	
.50% nickel	20xx
1.50% nickel	21xx
3.50% nickel	23xx
5.00% nickel	25xx
Nickel-Chromium Steels	
1.25% nickel, .65% chromium	31xx
1.75% nickel, 1.00% chromium	32xx
3.50% nickel, 1.57% chromium	33xx
3.00% nickel, .80% chromium	34xx
Corrosion and heat-resisting steels	303xx
Molybdenum Steels	
Chromium	41xx
Chromium-nickel	43xx
Nickel	46xx and 48xx
Chromium Steels	
Low-chromium	50xx
Medium-chromium	511xx
High-chromium	521xx
Chromium-Vanadium Steels	6xxx
Tungsten Steels	7xxx and 7xxxx
Triple-Alloy Steels	8xxx
Silicon-Manganese Steels	9xxx
Leaded steels	11Lxx (example)

WLD-J4-HO5
Verify Joint Preparation
Attachment 5: **MASTER** Handout No. 5

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Briefly describe and list the advantages and disadvantages for each of the following: casting processes, hot working processes, and cold working processes;
b. Discuss service requirements (strength, hardness, etc.);
c. Discuss fastening processes (fasteners, welding, bonding, etc.); and,
d. Discuss corrosion resistance methods.

MODULE OUTLINE:

I. Describe Casting Processes
    A. Discuss the following casting processes: sand, evaporative, shell molding, permanent mold, centrifugal, investment, and die casting
    B. Discuss pattern and mold design factors for each of the above casting processes
    C. List the advantages and disadvantages of the casting processes
II. Describe Hot Working Processes
    A. Discuss the following hot working processes: rolling, strand casting, forging, drawing, extrusion, spinning, and roll forming
    B. List the advantages and disadvantages of the hot working processes
III. Describe Cold Working Processes
    A. Discuss the following cold working processes: rolling, blanking, pressing, drawing, extruding, wire and bar drawing, bending, shearing, and roll forming
    B. List the advantages and disadvantages of the cold working process
IV. Evaluate Alternative Manufacturing Processes
    A. Discuss the powder metallurgy process (PM)
    B. Discuss the following nontraditional machining processes: EDM, laser machining, ultrasonic machining, hydrojet machining, electron beam machining, and plasma beam machining

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using technique that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDs.PM8
07/2000

2473

2474

Duty K

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on lilfe of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-K1-HO
Identify and Describe the Function of Each Piece of Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit, the student will be able to:

A. Understand basic fundamentals and scientific principles involved in the welding process;

B. Demonstrate the safe handling, use, and storage of oxygen and fuel gas cylinders;

C. Identify oxygen and fuel gas cylinders, oxygen and fuel gas regulators, torch handles, welding tips, cutting torch assemblies, and friction lighters;

D. Use a tip cleaner on oxyacetylene equipment;

E. Demonstrate the assembly and function of each piece of oxyfuel equipment; and,

F. Perform leak detection, safe startup, lighting, and shutdown of equipment.

MODULE OUTLINE:

Instruction Topics:

A. Identify oxygen and fuel gas cylinders

B. Describe preventive and protective measures in use of tools and equipment

C. Illustrate the function of oxygen equipment, fuel gas regulators, and gages

D. Demonstrating pressure adjustments, and inlet/outlet connections

E. Emphasize nomenclature and purpose of components.

F. Demonstrate the selection and use of torches, tips, and friction lighters

G. Illustrate techniques for start up, lighting, and shut down of equipment

H. Introduce methods associated with cutting and welding

Student Activities:

A. Identify, understand, and demonstrate the safe use of equipment at the introductory level.

B. Observe and be coached by the instructor in the introductory set up and shutdown of oxyacetylene gas welding equipment.

WLD-K1-LA

Identify and Describe the Function of Each Piece of Equipment

Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.
l. Never use any cylinder, full or empty, as a roller or support.
m. Never use oxygen as though it were compressed air.
n. Do not handle oxygen cylinders on the same platform with oil.
o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
p. Store oxygen cylinders separately from fuel gas cylinders.
q. Always keep empty cylinders separate from full cylinders.
r. Mark all empty cylinders as such after use.
s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
t. Never bring any arc or flame close to or directly into contact with a cylinder.
u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K1-LW1
Identify and Describe the Function of Each Piece of Equipment
Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?
2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?
3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?
4. What are the steps in preparing to cut with oxyacetylene?
5. What are the steps in lighting the torch?
6. What are the steps in cutting metal with the torch?
7. What are the steps in extinguishing the torch?
8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
    a. Use goggles or shield with a number five shade.
    b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
    c. When lighting the torch, direct the torch away from yourself and other personnel.
    d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
    e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
    f. Never cut on containers that have contained flammable or toxic substances.
    g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
    h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
   a. Keep acetylene operating pressures at or below 15 psi.
   b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   g. Never use a cylinder that is leaking.
   h. Store and transport cylinders in the upright position.
   i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   j. Never tamper with fusible plugs or other safety devices on cylinders.
   k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   l. Never use any cylinder, full or empty, as a roller or support.
   m. Never use oxygen as though it were compressed air.
   n. Do not handle oxygen cylinders on the same platform with oil.
   o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
   p. Store oxygen cylinders separately from fuel gas cylinders.
   q. Always keep empty cylinders separate from full cylinders.
   r. Mark all empty cylinders as such after use.
   s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   t. Never bring any arc or flame close to or directly into contact with a cylinder.
   u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
    - a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
    - b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
    - c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
    - d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
    - a. Obtain the proper size cutting tip.
        - (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
        - (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
    - b. Screw the cutting torch head in place, hand-tight only.
    - c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
    - d. Attach the regulators, hoses, torch, and correct-sized torch tip.
    - e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
    - f. Make sure all cutting torch valves are initially closed.
    - g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
    - h. Open the acetylene torch valve. Turn the acetylene torch valve off.

   - i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
   - j. Turn the acetylene torch valve off.
   - k. Turn both oxygen torch valves on.
   - l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
   - m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   - a. Put on gloves.
   - b. Put on welding goggles.
   - c. Open the torch acetylene valve one-half turn.
   - d. Immediately light the torch with a *friction lighter only.*
   - e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   - f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
     - (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
     - (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   - a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
     - (1) Cutting tip size.
     - (2) Oxygen operating pressure.
     - (3) Acetylene operating pressure.
     - (4) Preheat flame type.
     - (5) Size of preheat flame
   - b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
   - c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
   - d. Select the correct torch angle.
     - (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
     - (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

(3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed,* the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. Open the torch acetylene valve and bleed the acetylene from the line.
   d. Close the torch acetylene valve.
   e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
   f. Open the torch oxygen valve and bleed the oxygen from the line.
   g. Close the torch oxygen valve.
   h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K1-LW2

Identify and Describe the Function of Each Piece of Equipment

Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

WLD-K2-HO1
Identify the Safety Hazards
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Discuss the safety hazards associated with ignition and combustion;
B. Discuss the effect of an oxygen enriched environment;
C. Discuss the importance of ventilation in the oxyacetylene area;
D. Illustrate how to check the connections for leaks;
E. Review the use of check valves and flash arresters;
F. Discuss the importance of making sure o-rings are in good condition;
G. Demonstrate practice of indicators and detection measures for gas leaks;
H. Explain the function of Material Safety Data Sheets; and,
I. Explain the classes of fires and the types of extinguishers.

PRESENTATION OUTLINE:

Instruction Topics:

A. Identify safety hazards
B. Demonstrate preventive and protective measures
C. Describe the function of Material Safety and Data Sheets
D. Explain and practice safe lockout/tagout procedures
E. Practice safe work procedures around electrical hazards
F. Use respiratory protection equipment
G. Safe use of welders hand tools and power tools
H. Demonstrate how to set up and connect equipment
I. Demonstrate how to make pressure adjustments

Student Activities:

A. Inspection of welding shop for all possible safety hazards.
B. Select and demonstrate proper use of personal protective equipment, to include eye protection with required shade of lens, hearing protection, radiation and heat protection methods, and respiratory protection
C. Practice safe methods for lighting, safe use of ladders and scaffolds
D. Practice safe methods for electrical hazards and protection against shock
E. Review HazCom Standards and locate Material Safety Data Sheets

WLD-K2-HO2
Identify the Safety Hazards
Attachment 2: **MASTER** Handout No. 2

INTRODUCTION:

Welding is considered to be a hazardous occupation. Welding operations are used to cut, repair, and fabricate. Successful use of the welding torch, welding apparatus, and welding machines is based in safe operating procedures.

MODULE OUTLINE:

DON'T CARRY A BOMB IN YOUR POCKET!

NEVER carry a butane lighter into a welding area. These are mini-Molotov cocktails.

I. Safety Procedures Specific to the Welding Process
   A. Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.
      1. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
      2. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
      3. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask
      4. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.
   B. Electrical shock can be avoided by following specific safety precautions.
      1. Do not touch live electrical parts.
      2. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
      3. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
      4. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
      5. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
      6. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.

7. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
8. Shut off electrical power when working on welding equipment.

C. Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

1. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
2. Cover all skin surfaces. Keep shirt sleeves rolled down.
3. Wear cuffless pants to eliminate spatter traps.
4. Wear leather boots. Pant legs should cover boot tops.
5. Wear clean clothing. Oil- and grease-stained clothes will tend to ignite from welding spatter.
6. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
7. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
8. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
9. Wear a 100% cotton cap to protect the head from sparks or spatter.
10. Wear long-gauntlet leather gloves.
11. Do not touch hot metal with bare hands. Use tongs or pliers and wear leather gloves.
12. Protect nearby workers from exposure to the welding arc by putting up shields.
13. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (See Figure 1).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	Minimum Shade No.	Suggested Shade*
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to the next lighter shade until you find one which gives you sufficient view of the arc zone without exerting a strain on your eyes.

FIGURE 1 FILTER RECOMMENDATIONS

D. Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

   1. If possible, weld in specially designated areas or enclosures of noncombustible construction.
   2. Remove combustibles from the work area by at least 35 feet if possible.
   3. Cover combustibles that cannot be removed from the welding area with tight-fitting, flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.
   4. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.
   5. If combustibles cannot be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.
   6. Do not weld on materials having either a coating or internal structure that is combustible.
   7. Place hot scrap and slag in non-combustible containers.
   8. Ensure that fire extinguishers are available nearby.
   9. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.
   10. Follow all company safety procedures regarding welding in hazardous areas.

E. Specific Safety Precautions for Oxyacetylene Equipment

CAUTION: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment:

   1. Use goggles or shield with a number five shade.
   2. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
   3. When lighting the torch, direct the torch away from yourself and other personnel.
   4. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
   5. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
   6. Never cut on containers that have contained flammable or toxic substances.
   7. Either move work away from or protect wooden or other flammable materials which may be close to the work.
   8. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.
   9. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.

10. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.

11. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

F. Specific Safety Precautions for Acetylene and Oxygen Cylinders

CAUTION: Handle acetylene and oxygen cylinders carefully:

1. Keep acetylene operating pressures at or below 15 psi.
2. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
3. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
4. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene, hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
5. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
6. Do not use pipe-fitting compounds or thread lubricants for making connections.
7. Never use a cylinder that is leaking.
8. Store and transport cylinders in the upright position.
9. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
10. Never tamper with fusible plugs or other safety devices on cylinders.
11. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
12. Never use any cylinder, full or empty, as a roller or support.
13. Never use oxygen as though it were compressed air.
14. Do not handle oxygen cylinders on the same platform with oil.
15. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
16. Store oxygen cylinders separately from fuel gas cylinders.
17. Always keep empty cylinders separate from full cylinders.
18. Mark all empty cylinders as such after use.
19. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
20. Never bring any arc or flame close to or directly into contact with a cylinder.
21. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment.

If additional flow is needed, then manifold the required number of cylinders together.

G. Specific Safety Precautions for Regulator Burnout (R.B.O.)

CAUTION: Avoid potentially deadly regulator burnout (R.B.O.). Regulator burnout is a spontaneous explosion that happens when a torch is being lit. To minimize the risk of R.B.O., follow these safety precautions:

1. "Crack" the oxygen cylinder valve (open it slightly) before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
2. Use only oxygen regulators to control oxygen supply. A pressure-reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal, dust, and other combustibles can cause regulator burnout. Never use an oxygen regulator for other gases.
3. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
4. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

II. Describe the SMAW Process

Shielded Metal Arc Welding is a welding process which joins metals by heating them with an arc between a covered metal electrode and the metals being joined. Shielding is obtained from the decomposition (breakdown) of the electrode covering. Pressure is not used and filler metal is obtained from the electrode. The electric arc flowing across an air gap produces very intense heat and light. An electric arc has been measured at 10,000°F. Considering that steel melts at around 2800°F, the electric arc is indeed a very fast and efficient heat source for melting steel when welding.

III. Describe the Oxyacetylene Cutting and Welding Process

Oxyacetylene cutting requires the use of specific procedures and specific techniques in order to work safely and to produce acceptable cuts. Proper flame adjustments, torch angles, and flame-to-work distances must be maintained in order to produce good cuts. Oxyacetylene cutting can be done from both fixed cutting stations and from portable cutting stations. The key operations to oxyacetylene cutting are as follows:

1. Prepare to cut.
2. Light the torch.
3. Cut metal with the torch.

4. Extinguish the torch.

HOW TO SELECT THE CORRECT NUMBER OF ACETYLENE CYLINDERS

To determine the number of cylinders required for proper manifold operation, follow the guidelines below:

1. The number of cylinders in the manifold is determined by the volume of gas in cubic feet per hour required. Determine the cubic feet per hour required for the largest tip used and multiply that by the number of torches or stations in operation at the same time. This will give the total volume of each gas required per hour.

2. The manifold should have enough. cylinders to provide a minimum of one day's requirements

3. Maximum acetylene withdrawal for continuous operation is 1/7 (of 14%) of each cylinder capacity per hour. The chart allows for 7.8% excess capacity

CFH Acetylene withdrawal per hour required	Number of 300 cubic foot cylinders per manifold
40	1
80	2
120	3
160	4
200	5
240	6
280	7
320	8
360	9
400	10
440	11
480	12
520	13
560	14
600	15
640	16
680	17
720	18
760	19
800	20

Acetylene Cylinder Manifold Guide

IV. Describe the GTAW (Heliarc) Process

V. Describe the GMAW (MIG) Process

VI. Describe the Band/Flash Welding Machine and Process

WLD-K2-LA
Identify the Safety Hazards
Attachment 3: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K2-LW1
Identify the Safety Hazards
Attachment 4 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?
2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?
3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?
4. What are the steps in preparing to cut with oxyacetylene?
5. What are the steps in lighting the torch?
6. What are the steps in cutting metal with the torch?
7. What are the steps in extinguishing the torch?
8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
    a. Use goggles or shield with a number five shade.
    b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
    c. When lighting the torch, direct the torch away from yourself and other personnel.
    d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
    e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
    f. Never cut on containers that have contained flammable or toxic substances.
    g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
    h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

    i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
    j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
    k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
    a. Keep acetylene operating pressures at or below 15 psi.
    b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
    c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
    d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
    e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
    f. Do not use pipe-fitting compounds or thread lubricants for making connections.
    g. Never use a cylinder that is leaking.
    h. Store and transport cylinders in the upright position.
    i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
    j. Never tamper with fusible plugs or other safety devices on cylinders.
    k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
    l. Never use any cylinder, full or empty, as a roller or support.
    m. Never use oxygen as though it were compressed air.
    n. Do not handle oxygen cylinders on the same platform with oil.
    o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
    p. Store oxygen cylinders separately from fuel gas cylinders.
    q. Always keep empty cylinders separate from full cylinders.
    r. Mark all empty cylinders as such after use.
    s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
    t. Never bring any arc or flame close to or directly into contact with a cylinder.
    u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
   a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
   b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
   c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
   d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
   a. Obtain the proper size cutting tip.
      (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
      (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
   b. Screw the cutting torch head in place, hand-tight only.
   c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
   d. Attach the regulators, hoses, torch, and correct-sized torch tip.
   e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
   f. Make sure all cutting torch valves are initially closed.
   g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
   h. Open the acetylene torch valve. Turn the acetylene torch valve off.

   i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
   j. Turn the acetylene torch valve off.
   k. Turn both oxygen torch valves on.
   l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
   m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   a. Put on gloves.
   b. Put on welding goggles.
   c. Open the torch acetylene valve one-half turn.
   d. Immediately light the torch with a *friction lighter only*.
   e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
      (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
      (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
      (1) Cutting tip size.
      (2) Oxygen operating pressure.
      (3) Acetylene operating pressure.
      (4) Preheat flame type.
      (5) Size of preheat flame
   b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
   c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
   d. Select the correct torch angle.
      (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
      (2) For *beveled cuts*, the torch should be held at the angle of the bevel throughout the cutting procedure.

(3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed,* the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. Open the torch acetylene valve and bleed the acetylene from the line.
   d. Close the torch acetylene valve.
   e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
   f. Open the torch oxygen valve and bleed the oxygen from the line.
   g. Close the torch oxygen valve.
   h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K2-LW2
Identify the Safety Hazards
Attachment 5: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

WLD-K3-HO
Describe Preventive and/or Protective Measures
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify the protective clothing and equipment used by welders;
B. Explain the purpose and use of personal protective equipment;
C. Identify the safety precautions such as the importance of locating gas lines and checking for leaks before operating equipment; and.
D. Demonstrate proper body position, protective measures involving positioning the body in safe relationship to the work and the torch, and layout of the work with clamps and fixtures.

PRESENTATION OUTLINE:

Instruction Topics:

A. Purpose of wearing personal protective equipment
B. Identify potential safety hazards for all items of equipment
C. Describe protective and accident preventive measures
D. Illustrate the function of personal protective equipment (Hard Hat, Required Lens Shade, Safety Glasses, Safety Shoes, Hearing Protection Devices, and Respiratory Protection Equipment)
E. Understand the U.S. Dept. of Labor's Occupational Safety and Health Administration's Hazard Communication Standard (HazCom)

Student Activities:

A. Select and demonstrate proper use of personal protective equipment, to include eye protection with required shade of lens, hearing protection, radiation and heat protection methods, and respiratory protection
B. Practice safe methods for lighting, safe use of ladders and scaffolds
C. Practice safe methods for electrical hazards and protection against shock
D. Review HazCom Standards and locate Material Safety Data Sheets
E. Practice the use of respiratory equipment

WLD-K3-LA
Describe Preventive and/or Protective Measures
Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K3-LW1
Describe Preventive and/or Protective Measures
Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?
2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?
3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?
4. What are the steps in preparing to cut with oxyacetylene?
5. What are the steps in lighting the torch?
6. What are the steps in cutting metal with the torch?
7. What are the steps in extinguishing the torch?
8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
   a. Use goggles or shield with a number five shade.
   b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
   c. When lighting the torch, direct the torch away from yourself and other personnel.
   d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
   e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
   f. Never cut on containers that have contained flammable or toxic substances.
   g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
   h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.

j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.

k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
   a. Keep acetylene operating pressures at or below 15 psi.
   b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   g. Never use a cylinder that is leaking.
   h. Store and transport cylinders in the upright position.
   i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   j. Never tamper with fusible plugs or other safety devices on cylinders.
   k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   l. Never use any cylinder, full or empty, as a roller or support.
   m. Never use oxygen as though it were compressed air.
   n. Do not handle oxygen cylinders on the same platform with oil.
   o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
   p. Store oxygen cylinders separately from fuel gas cylinders.
   q. Always keep empty cylinders separate from full cylinders.
   r. Mark all empty cylinders as such after use.
   s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   t. Never bring any arc or flame close to or directly into contact with a cylinder.
   u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
    a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
    b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
    c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
    d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
    a. Obtain the proper size cutting tip.
        (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
        (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
    b. Screw the cutting torch head in place, hand-tight only.
    c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
    d. Attach the regulators, hoses, torch, and correct-sized torch tip.
    e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
    f. Make sure all cutting torch valves are initially closed.
    g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
    h. Open the acetylene torch valve. Turn the acetylene torch valve off.

- i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
- j. Turn the acetylene torch valve off.
- k. Turn both oxygen torch valves on.
- l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
- m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   - a. Put on gloves.
   - b. Put on welding goggles.
   - c. Open the torch acetylene valve one-half turn.
   - d. Immediately light the torch with a *friction lighter only*.
   - e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   - f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
     - (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
     - (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   - a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
     - (1) Cutting tip size.
     - (2) Oxygen operating pressure.
     - (3) Acetylene operating pressure.
     - (4) Preheat flame type.
     - (5) Size of preheat flame
   - b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
   - c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
   - d. Select the correct torch angle.
     - (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
     - (2) For *beveled cuts*, the torch should be held at the angle of the bevel throughout the cutting procedure.

        (3) For *holes*, the torch must be held perpendicular to the base metal throughout the cut.

    e. Cut at the proper travel speed. At the *correct travel speed*, the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed*, the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)

    f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
    a. Close the torch acetylene valve, thus extinguishing the flame.
    b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
    a. Close the oxygen cylinder valve.
    b. Close the acetylene cylinder valve.
    c. Open the torch acetylene valve and bleed the acetylene from the line.
    d. Close the torch acetylene valve.
    e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
    f. Open the torch oxygen valve and bleed the oxygen from the line.
    g. Close the torch oxygen valve.
    h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K3-LW2
Describe Preventive and/or Protective Measures
Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

WLD-K4-HO

List the Welding Variables and Describe Their Effects on Weld Quality

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to the visual examination of welds;
B. Perform visual examination of welds;
C. Discuss common weld discontinuities;
D. Explain the impact of welding variables on oxyacetylene processes; and,
E. Demonstrate brazing and soldering techniques.

MODULE OUTLINE:

Instruction Topics:

A. Continue to illustrate the function of Oxyacetylene equipment
B. Demonstrate discontinuities and their effects on weld quality
C. Illustrate welding variables and how procedures can maintain weld quality
D. Illustrate proper techniques of applying welds or beads in various positions
E. Illustrate variables associated with cutting
F. Demonstrate brazing and soldering of various metals in various positions

Student Activities:

A. Identify weld discontinuities
B. Remove discontinuities from cut area using grinders and files
C. Remove oxidation for welding
D. Demonstrate proper cleaning techniques
E. Oxyacetylene weld practice pieces
F. Explain weld variables and use of filler metal for each welding example
G. Evaluate the process followed for each example
H. Braze and silver solder mild steel in various positions

WLD-K4-LA

List the Welding Variables and Describe Their Effects on Weld Quality

Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K4-LW1
List the Welding Variables and Describe Their Effects on Weld Quality
Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?
2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?
3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?
4. What are the steps in preparing to cut with oxyacetylene?
5. What are the steps in lighting the torch?
6. What are the steps in cutting metal with the torch?
7. What are the steps in extinguishing the torch?
8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
    a. Use goggles or shield with a number five shade.
    b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
    c. When lighting the torch, direct the torch away from yourself and other personnel.
    d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
    e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
    f. Never cut on containers that have contained flammable or toxic substances.
    g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
    h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

   - i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
   - j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
   - k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
   - a. Keep acetylene operating pressures at or below 15 psi.
   - b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   - c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   - d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   - e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   - f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   - g. Never use a cylinder that is leaking.
   - h. Store and transport cylinders in the upright position.
   - i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   - j. Never tamper with fusible plugs or other safety devices on cylinders.
   - k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   - l. Never use any cylinder, full or empty, as a roller or support.
   - m. Never use oxygen as though it were compressed air.
   - n. Do not handle oxygen cylinders on the same platform with oil.
   - o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
   - p. Store oxygen cylinders separately from fuel gas cylinders.
   - q. Always keep empty cylinders separate from full cylinders.
   - r. Mark all empty cylinders as such after use.
   - s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   - t. Never bring any arc or flame close to or directly into contact with a cylinder.
   - u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
   a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
   b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
   c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
   d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
   a. Obtain the proper size cutting tip.
      (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
      (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
   b. Screw the cutting torch head in place, hand-tight only.
   c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
   d. Attach the regulators, hoses, torch, and correct-sized torch tip.
   e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
   f. Make sure all cutting torch valves are initially closed.
   g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
   h. Open the acetylene torch valve. Turn the acetylene torch valve off.

    i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
    j. Turn the acetylene torch valve off.
    k. Turn both oxygen torch valves on.
    l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
    m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
    a. Put on gloves.
    b. Put on welding goggles.
    c. Open the torch acetylene valve one-half turn.
    d. Immediately light the torch with a *friction lighter only*.
    e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
    f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
        (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
        (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
    a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
        (1) Cutting tip size.
        (2) Oxygen operating pressure.
        (3) Acetylene operating pressure.
        (4) Preheat flame type.
        (5) Size of preheat flame
    b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
    c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
    d. Select the correct torch angle.
        (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
        (2) For *beveled cuts*, the torch should be held at the angle of the bevel throughout the cutting procedure.

        (3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

    e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed,* the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)

    f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
    a. Close the torch acetylene valve, thus extinguishing the flame.
    b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
    a. Close the oxygen cylinder valve.
    b. Close the acetylene cylinder valve.
    c. Open the torch acetylene valve and bleed the acetylene from the line.
    d. Close the torch acetylene valve.
    e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
    f. Open the torch oxygen valve and bleed the oxygen from the line.
    g. Close the torch oxygen valve.
    h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K4-LW2

List the Welding Variables and Describe Their Effects on Weld Quality

Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

WLD-K5-HO

Describe the AWS Oxyfuel Gas Welding Rod Classification System

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Classify filler metal for oxy-fuel gas welding;
B. Identify parent metal compatibility with filler metal; and,
C. Select welding tips required for the process.

PRESENTATION OUTLINE:

Instruction Topics:

A. Welding Rod defined as: "a filler metal used for welding or brazing which does not conduct the electric current."
B. Welding rod types, lengths and diameters
C. Common welding rods: mild steel, cast iron, stainless steel, braze welding alloys, aluminum (drawn, extended, cast)
D. Mil-Specifications and AWS Specification numbers
E. Illustrate AWS Oxyacetylene Rod Classification System
F. Factors in selecting welding tips for varied work and thickness of metal

Student Activities:

A. Selection of filler metal based upon compatibility charts and alloy charts
B. Selection of welding tips to perform the work
C. Perform welds using selected filler metals
D. Testing of weld for discontinuities and strength

WLD-K5-LA
Describe the AWS Oxyfuel Gas Welding Rod Classification System
Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.
l. Never use any cylinder, full or empty, as a roller or support.
m. Never use oxygen as though it were compressed air.
n. Do not handle oxygen cylinders on the same platform with oil.
o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
p. Store oxygen cylinders separately from fuel gas cylinders.
q. Always keep empty cylinders separate from full cylinders.
r. Mark all empty cylinders as such after use.
s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
t. Never bring any arc or flame close to or directly into contact with a cylinder.
u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K5-LW1

Describe the AWS Oxyfuel Gas Welding Rod Classification System

Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?
2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?
3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?
4. What are the steps in preparing to cut with oxyacetylene?
5. What are the steps in lighting the torch?
6. What are the steps in cutting metal with the torch?
7. What are the steps in extinguishing the torch?
8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
    a. Use goggles or shield with a number five shade.
    b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
    c. When lighting the torch, direct the torch away from yourself and other personnel.
    d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
    e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
    f. Never cut on containers that have contained flammable or toxic substances.
    g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
    h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

    - i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
    - j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
    - k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
    - a. Keep acetylene operating pressures at or below 15 psi.
    - b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
    - c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
    - d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
    - e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
    - f. Do not use pipe-fitting compounds or thread lubricants for making connections.
    - g. Never use a cylinder that is leaking.
    - h. Store and transport cylinders in the upright position.
    - i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
    - j. Never tamper with fusible plugs or other safety devices on cylinders.
    - k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
    - l. Never use any cylinder, full or empty, as a roller or support.
    - m. Never use oxygen as though it were compressed air.
    - n. Do not handle oxygen cylinders on the same platform with oil.
    - o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
    - p. Store oxygen cylinders separately from fuel gas cylinders.
    - q. Always keep empty cylinders separate from full cylinders.
    - r. Mark all empty cylinders as such after use.
    - s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
    - t. Never bring any arc or flame close to or directly into contact with a cylinder.
    - u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
    a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
    b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
    c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
    d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
    a. Obtain the proper size cutting tip.
        (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
        (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
    b. Screw the cutting torch head in place, hand-tight only.
    c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
    d. Attach the regulators, hoses, torch, and correct-sized torch tip.
    e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
    f. Make sure all cutting torch valves are initially closed.
    g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
    h. Open the acetylene torch valve. Turn the acetylene torch valve off.

i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
j. Turn the acetylene torch valve off.
k. Turn both oxygen torch valves on.
l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
    a. Put on gloves.
    b. Put on welding goggles.
    c. Open the torch acetylene valve one-half turn.
    d. Immediately light the torch with a *friction lighter only*.
    e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
    f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
        (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
        (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
    a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
        (1) Cutting tip size.
        (2) Oxygen operating pressure.
        (3) Acetylene operating pressure.
        (4) Preheat flame type.
        (5) Size of preheat flame
    b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
    c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
    d. Select the correct torch angle.
        (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
        (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

(3) For *holes*, the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the *correct travel speed*, the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed*, the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. Open the torch acetylene valve and bleed the acetylene from the line.
   d. Close the torch acetylene valve.
   e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
   f. Open the torch oxygen valve and bleed the oxygen from the line.
   g. Close the torch oxygen valve.
   h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K5-LW2

Describe the AWS Oxyfuel Gas Welding Rod Classification System

Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

WLD-K6-HO

Describe Techniques for Preventing or Reducing Welding Related Distortion

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand stresses caused by welding processes;
B. Use fixtures and clamps to minimize distortion;
C. Understand metal properties exhibited by heating and cooling;
D. Relieve internal stresses by heat treatment; and,
E. Prepare trainee for the related sections of ANSI/AWS C4.2, Operator's Manual for Oxyfuel Gas Cutting and AWS C4.1, Criteria for Describing Oxygen-Cut Surfaces.

MODULE OUTLINE:

Instruction Topics:

A. Describe stresses caused by welding and the expansion rate of metal
B. Describe heat created by the welding process causing expansion
C. Describe contraction or shrinking caused by cooling
D. If metal does not return to original shape, explain how distortion has occurred
E. Reduce distortion by clamping parts into a fixture while welding
F. Discuss metal properties changed by heat and expansion factors
G. Demonstrate residual stresses relieved by heat treatment
H. Judge temperature by color of materials

Student Activities:

A. Perform welding experiments in heating and contraction of specific metals
B. Practice welding exercises using fixtures and clamping
C. Practice stress relief by heat treatment

WLD-K6-LA

Describe Techniques for Preventing or Reducing Welding Related Distortion

Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K6-LW1

Describe Techniques for Preventing or Reducing Welding Related Distortion

Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?

2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?

3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?

4. What are the steps in preparing to cut with oxyacetylene?

5. What are the steps in lighting the torch?

6. What are the steps in cutting metal with the torch?

7. What are the steps in extinguishing the torch?

8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
    a. Use goggles or shield with a number five shade.
    b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
    c. When lighting the torch, direct the torch away from yourself and other personnel.
    d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
    e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
    f. Never cut on containers that have contained flammable or toxic substances.
    g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
    h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

    i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
    j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
    k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
    a. Keep acetylene operating pressures at or below 15 psi.
    b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
    c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
    d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
    e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
    f. Do not use pipe-fitting compounds or thread lubricants for making connections.
    g. Never use a cylinder that is leaking.
    h. Store and transport cylinders in the upright position.
    i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
    j. Never tamper with fusible plugs or other safety devices on cylinders.
    k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
    l. Never use any cylinder, full or empty, as a roller or support.
    m. Never use oxygen as though it were compressed air.
    n. Do not handle oxygen cylinders on the same platform with oil.
    o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
    p. Store oxygen cylinders separately from fuel gas cylinders.
    q. Always keep empty cylinders separate from full cylinders.
    r. Mark all empty cylinders as such after use.
    s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
    t. Never bring any arc or flame close to or directly into contact with a cylinder.
    u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
    a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
    b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
    c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
    d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
    a. Obtain the proper size cutting tip.
        (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
        (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
    b. Screw the cutting torch head in place, hand-tight only.
    c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
    d. Attach the regulators, hoses, torch, and correct-sized torch tip.
    e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
    f. Make sure all cutting torch valves are initially closed.
    g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
    h. Open the acetylene torch valve. Turn the acetylene torch valve off.

   i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
   j. Turn the acetylene torch valve off.
   k. Turn both oxygen torch valves on.
   l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
   m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   a. Put on gloves.
   b. Put on welding goggles.
   c. Open the torch acetylene valve one-half turn.
   d. Immediately light the torch with a *friction lighter only.*
   e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
      (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
      (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
      (1) Cutting tip size.
      (2) Oxygen operating pressure.
      (3) Acetylene operating pressure.
      (4) Preheat flame type.
      (5) Size of preheat flame
   b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
   c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
   d. Select the correct torch angle.
      (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
      (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

   (3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed,* the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. Open the torch acetylene valve and bleed the acetylene from the line.
   d. Close the torch acetylene valve.
   e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
   f. Open the torch oxygen valve and bleed the oxygen from the line.
   g. Close the torch oxygen valve.
   h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K6-LW2

Describe Techniques for Preventing or Reducing Welding Related Distortion

Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

WLD-K7-HO
Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion
Attachment 1: MASTER Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform welding with mild steel and carbon steel using variety of joints and types of leads and welds;
B. Weld intermittent blocks to decrease distortion;
C. Learn other techniques to prevent warpage and distortion; and,
D. Remove distortion using gas equipment.

MODULE OUTLINE:

Instruction Topics:

A. Identify safety hazards
B. Describe preventive and protective measures
C. Illustrate the function of oxyacetylene equipment
D. Illustrate discontinuities and their effects on weld quality
E. Illustrate AWS Oxyacetylene Rod Classification System
F. Illustrate techniques for preventing or reducing weld related distortion, weld flat plate using stringer bead in flat and horizontal, vertical, and overhead positions; flat plate using weave bead in flat position; lap joint using filler weld in flat position, horizontal, vertical, and overhead positions.
G. Illustrate variables associated with cutting
H. Remove distortion using gas equipment

Student Activities:

A. Cut mild steel plates in a safe manner
B. Remove discontinuities from cut area using grinders and files
C. Remove oxidation prior to and after welding
D. Oxyacetylene weld practice pieces using multiple positions

WLD-K7-LA
Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion
Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.

j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K7-LW1

WLD-K7-LW1

Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion

Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. **What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?**

2. **What are the precautions for safely handling and storing acetylene and oxygen cylinders?**

3. **What are the precautions for minimizing the risk of regulatory burn out (R.B.O.)?**

4. **What are the steps in preparing to cut with oxyacetylene?**

5. **What are the steps in lighting the torch?**

6. **What are the steps in cutting metal with the torch?**

7. **What are the steps in extinguishing the torch?**

8. **What are the steps in closing down the welding station?**

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
    a. Use goggles or shield with a number five shade.
    b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
    c. When lighting the torch, direct the torch away from yourself and other personnel.
    d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
    e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
    f. Never cut on containers that have contained flammable or toxic substances.
    g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
    h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

   - i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
   - j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
   - k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
   - a. Keep acetylene operating pressures at or below 15 psi.
   - b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   - c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   - d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   - e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   - f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   - g. Never use a cylinder that is leaking.
   - h. Store and transport cylinders in the upright position.
   - i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   - j. Never tamper with fusible plugs or other safety devices on cylinders.
   - k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   - l. Never use any cylinder, full or empty, as a roller or support.
   - m. Never use oxygen as though it were compressed air.
   - n. Do not handle oxygen cylinders on the same platform with oil.
   - o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
   - p. Store oxygen cylinders separately from fuel gas cylinders.
   - q. Always keep empty cylinders separate from full cylinders.
   - r. Mark all empty cylinders as such after use.
   - s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   - t. Never bring any arc or flame close to or directly into contact with a cylinder.
   - u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
   a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
   b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
   c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
   d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
   a. Obtain the proper size cutting tip.
      (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
      (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
   b. Screw the cutting torch head in place, hand-tight only.
   c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
   d. Attach the regulators, hoses, torch, and correct-sized torch tip.
   e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
   f. Make sure all cutting torch valves are initially closed.
   g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
   h. Open the acetylene torch valve. Turn the acetylene torch valve off.

- i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
- j. Turn the acetylene torch valve off.
- k. Turn both oxygen torch valves on.
- l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
- m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
   - a. Put on gloves.
   - b. Put on welding goggles.
   - c. Open the torch acetylene valve one-half turn.
   - d. Immediately light the torch with a *friction lighter only.*
   - e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
   - f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
     - (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
     - (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
   - a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
     - (1) Cutting tip size.
     - (2) Oxygen operating pressure.
     - (3) Acetylene operating pressure.
     - (4) Preheat flame type.
     - (5) Size of preheat flame
   - b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
   - c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
   - d. Select the correct torch angle.
     - (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
     - (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

        (3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

    e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed,* the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)
    f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
    a. Close the torch acetylene valve, thus extinguishing the flame.
    b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
    a. Close the oxygen cylinder valve.
    b. Close the acetylene cylinder valve.
    c. Open the torch acetylene valve and bleed the acetylene from the line.
    d. Close the torch acetylene valve.
    e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
    f. Open the torch oxygen valve and bleed the oxygen from the line.
    g. Close the torch oxygen valve.
    h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K7-LW2

Weld Mild Steel Sheet Metal Using Techniques That Will Minimize the Effects of Distortion

Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
Braze with bronze rod;
Run a bead with a bronze rod;
Square butt braze on light steel plate;
Braze lap joints;
Braze tee joints;
Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
Silver soldering of nonferrous metals; and,
Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
Brazing with bronze rod;
Running beads with bronze rod;
Square butt brazing on light steel plate;
Brazed lap joints;
Brazing tee joints;
Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
Silver soldering nonferrous metals; and,
Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
Running beads with bronze rod;
Square butt brazing on light steel plate;
Brazed lap joints;
Brazing tee joints;
Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
Brazing beveled joints on cast iron;
Silver soldering nonferrous metals; and,
Silver soldering ferrous and nonferrous metals.

WLD-K8-HO
List the Variables Associated with Cutting
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to shape cutting operations using manual oxyfuel gas cutting equipment;
B. Provide instruction related to visual examination of flame cut edges and surfaces;
C. Demonstrate straight cuts on mild steel of 1/8", 1/4", 1/2", bevel cuts of 3/8", cut holes and shapes on 1/4" and 1/2";
D. Provide training exercises related to shape cutting operations on plain carbon steel, using manual oxyfuel gas cutting equipment;
E. Observe safe oxyfuel gas cutting practices;
F. Operate manual oxyfuel gas cutting and "track burner" equipment;
G. Visually inspect workmanship samples;
H. Understand various methods of cutting; and,
I.. Understand different tip sizes for material thickness.

MODULE OUTLINE:

Instruction Topics:

A. Identify safety hazards in oxyfuel gas cutting operations
B. Describe preventive and protective measures
C. Selection of tips for cutting
D. Demonstrate kerfing, gauging, scarfing, and washing
E. Demonstration on cutting steel: straight cuts, bevel cuts, holes and shapes
F. Demonstrate cutting methods in flat or horizontal, vertical, and overhead positions
G. Operation of manual oxyfuel gas cutting and track burner equipment
H. Importance of quality and safety in cutting methods
I. Review other methods of cutting (plasma, laser, water jet), with advantages and disadvantages
J. Evaluating quality of final workmanship

Student Activities:

A. Demonstrate safe techniques in use of oxyfuel gas cutting equipment
B. Perform straight cutting operations using manual oxyfuel gas cutting equipment
C. Perform straight cutting operations on plain carbon steel
D. Demonstrate straight cuts on mild steel of 1/8", 1/4", 1/2", bevel cuts of 3/8", cut holes and shapes on 1/4" and 1/2" with major emphasis on safety practice cutting from multiple positions under close supervision of instructor

E. Use "track burner" equipment
F. Perform shape cutting operations on plain carbon steel, using manual oxyfuel gas cutting equipment
G. Select and change tip size for material, appropriate size to each operation
H. Review different methods of cutting (i.e. plasma, laser, water jet, etc.)

WLD-K8-LA
List the Variables Associated with Cutting
Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K8-LW1
List the Variables Associated with Cutting
Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?
2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?
3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?
4. What are the steps in preparing to cut with oxyacetylene?
5. What are the steps in lighting the torch?
6. What are the steps in cutting metal with the torch?
7. What are the steps in extinguishing the torch?
8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
    a. Use goggles or shield with a number five shade.
    b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
    c. When lighting the torch, direct the torch away from yourself and other personnel.
    d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
    e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
    f. Never cut on containers that have contained flammable or toxic substances.
    g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
    h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders
   a. Keep acetylene operating pressures at or below 15 psi.
   b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   g. Never use a cylinder that is leaking.
   h. Store and transport cylinders in the upright position.
   i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   j. Never tamper with fusible plugs or other safety devices on cylinders.
   k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   l. Never use any cylinder, full or empty, as a roller or support.
   m. Never use oxygen as though it were compressed air.
   n. Do not handle oxygen cylinders on the same platform with oil.
   o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
   p. Store oxygen cylinders separately from fuel gas cylinders.
   q. Always keep empty cylinders separate from full cylinders.
   r. Mark all empty cylinders as such after use.
   s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   t. Never bring any arc or flame close to or directly into contact with a cylinder.
   u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. *Precautions for minimizing the risks of regulatory burn out (R.B.O).*
   a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
   b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
   c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
   d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. *Steps in preparing to cut with oxyacetylene*
   a. *Obtain the proper size cutting tip*
      (1) *Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.*
      (2) *Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.*
   b. Screw the cutting torch head in place, hand-tight only.
   c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
   d. Attach the regulators, hoses, torch, and correct-sized torch tip.
   e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
   f. Make sure all cutting torch valves are initially closed.
   g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
   h. Open the acetylene torch valve. Turn the acetylene torch valve off.

    i. *Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.*
    j. *Turn the acetylene torch valve off.*
    k. Turn both oxygen torch valves on.
    l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
    m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
    a. Put on gloves.
    b. Put on welding goggles.
    c. Open the torch acetylene valve one-half turn.
    d. Immediately light the torch with a friction lighter only.
    e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
    f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
        (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
        (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step f" again. If the preheat flame is too large, there will be or tends to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. *Steps in cutting metal with the torch:*
    a. *Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:*
        (1) *Cutting tip size.*
        (2) *Oxygen operating pressure.*
        (3) *Acetylene operating pressure.*
        (4) *Preheat flame type.*
        (5) *Size of preheat flame*
    b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
    c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
    d. Select the correct torch angle.
        (1) For square cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
        (2) For beveled cuts, the torch should be held at the angle of the bevel throughout the cutting procedure.

(3) *For holes, the torch must be held perpendicular to the base metal throughout the cut.*

e. *Cut at the proper travel speed. At the correct travel speed, the lines of the cut which project through the thickness of the base metal will be in a straight line. At too fast a travel speed, the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed lag or drag lines. (The amount of drag is often expressed as a percent.)*

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 93%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch.
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8. Steps in closing down the welding station.
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. *Open the torch acetylene valve and bleed the acetylene from the line.*
   d. *Close the torch acetylene valve.*
   e. *Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.*
   f. *Open the torch oxygen valve and bleed the oxygen from the line.*
   g. *Close the torch oxygen valve.*
   h. *Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.*

WLD-K8-LW2

List the Variables Associated with Cutting

Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

WLD-K9-HO
Cut Mild Steel Plate in a Safe Manner
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit, the student will be able to:

A. Perform quality multipass single vee groove welds;
B. Perform quality vee groove weld that will pass a guided bend test;
C. Produce quality single vee groove welds in the vertical position;
D. Produce quality single vee groove welds in the overhead position;
E. Produce quality single vee groove welds in the horizontal position;
F. Visually inspect workmanship samples; and,
G. Understand all welding procedures.

MODULE OUTLINE:

Instruction Topics:

A. Identify safety hazards.
B. Describe preventive and protective measures.
C. Demonstrate forcehand or backhand motions for gas welding
D. Adjust gas working pressures according to tip size, producing good fusion
E. Present and demonstrate welding techniques in the flat or horizontal, vertical, and overhead positions
F. Discuss types of welds and joints for carbon steel.
G. Discuss how to perform Single Groove Weld Guided Bend Test.

Student Activities:

Perform the following welding exercises:

A. Single Vee Groove Weld, Butt Joint, Flat Position
B. Single Vee Groove Weld, Guided Bend Test
C. Single Vee Groove Weld, Butt Joint, Vertical Position,
D. Single Vee Groove Weld, Butt Joint, Overhead Position
E. Single Vee Groove Weld, Butt Joint, Horizontal Position
F. Discuss advantages and disadvantages of typical gas working pressures

WLD-K9-LA
Cut Mild Steel Plate in a Safe Manner
Attachment 2: **MASTER** Laboratory Aid

Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover, concrete floors with sheet metal where sparks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.
l. Never use any cylinder, full or empty, as a roller or support.
m. Never use oxygen as though it were compressed air.
n. Do not handle oxygen cylinders on the same platform with oil.
o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
p. Store oxygen cylinders separately from fuel gas cylinders.
q. Always keep empty cylinders separate from full cylinders.
r. Mark all empty cylinders as such after use.
s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
t. Never bring any arc or flame close to or directly into contact with a cylinder.
u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

WLD-K9-LW1
Cut Mild Steel Plate in a Safe Manner
Attachment 3 **MASTER** Laboratory Worksheet No. 1

Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?

2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?

3. What are the precautions for minimizing the risk of regulatory burn out (R.B.O).?

4. What are the steps in preparing to cut with oxyacetylene?

5. What are the steps in lighting the torch?

6. What are the steps in cutting metal with the torch?

7. What are the steps in extinguishing the torch?

8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
    a. Use goggles or shield with a number five shade.
    b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
    c. When lighting the torch, direct the torch away from yourself and other personnel.
    d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
    e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
    f. Never cut on containers that have contained flammable or toxic substances.
    g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
    h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

- i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
- j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.
- k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
   - a. Keep acetylene operating pressures at or below 15 psi.
   - b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   - c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   - d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   - e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   - f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   - g. Never use a cylinder that is leaking.
   - h. Store and transport cylinders in the upright position.
   - i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   - j. Never tamper with fusible plugs or other safety devices on cylinders.
   - k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   - l. Never use any cylinder, full or empty, as a roller or support.
   - m. Never use oxygen as though it were compressed air.
   - n. Do not handle oxygen cylinders on the same platform with oil.
   - o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
   - p. Store oxygen cylinders separately from fuel gas cylinders.
   - q. Always keep empty cylinders separate from full cylinders.
   - r. Mark all empty cylinders as such after use.
   - s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   - t. Never bring any arc or flame close to or directly into contact with a cylinder.
   - u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of regulatory burn out (R.B.O).
    a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
    b. Use only oxygen regulators to control oxygen supply. A pressure reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
    c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns, freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
    d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
    a. Obtain the proper size cutting tip.
        (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
        (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
    b. Screw the cutting torch head in place, hand-tight only.
    c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
    d. Attach the regulators, hoses, torch, and correct-sized torch tip.
    e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counterclockwise until there is a little free play.)
    f. Make sure all cutting torch valves are initially closed.
    g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
    h. Open the acetylene torch valve. Turn the acetylene torch valve off.

    i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
    j. Turn the acetylene torch valve off.
    k. Turn both oxygen torch valves on.
    l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
    m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
    a. Put on gloves.
    b. Put on welding goggles.
    c. Open the torch acetylene valve one-half turn.
    d. Immediately light the torch with a *friction lighter only.*
    e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
    f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
        (1) The preheat flame needs to be of the neutral type, which means that equal parts of oxygen and acetylene are being burnt.
        (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut-assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
    a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
        (1) Cutting tip size.
        (2) Oxygen operating pressure.
        (3) Acetylene operating pressure.
        (4) Preheat flame type.
        (5) Size of preheat flame
    b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.
    c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.
    d. Select the correct torch angle.
        (1) For *square* cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
        (2) For *beveled cuts,* the torch should be held at the angle of the bevel throughout the cutting procedure.

        (3) For *holes,* the torch must be held perpendicular to the base metal throughout the cut.

    e. Cut at the proper travel speed. At the *correct travel speed,* the lines of the cut which project through the thickness of the base metal will be in a straight line. At *too fast a travel speed,* the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed *lag or drag* lines. (The amount of drag is often expressed as a percent.)
    f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
    a. Close the torch acetylene valve, thus extinguishing the flame.
    b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
    a. Close the oxygen cylinder valve.
    b. Close the acetylene cylinder valve.
    c. Open the torch acetylene valve and bleed the acetylene from the line.
    d. Close the torch acetylene valve.
    e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
    f. Open the torch oxygen valve and bleed the oxygen from the line.
    g. Close the torch oxygen valve.
    h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.

WLD-K9-LW2

Cut Mild Steel Plate in a Safe Manner

Attachment 4: **MASTER** Laboratory Worksheet No. 2

---

1. Instructor will demonstrate how to:
   Braze with bronze rod;
   Run a bead with a bronze rod;
   Square butt braze on light steel plate;
   Braze lap joints;
   Braze tee joints;
   Braze beveled butt joints on heavy steel plate; Braze beveled joints on cast iron;
   Silver soldering of nonferrous metals; and,
   Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   Brazing with bronze rod;
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on: Brazing with bronze rod:
   Running beads with bronze rod;
   Square butt brazing on light steel plate;
   Brazed lap joints;
   Brazing tee joints;
   Brazing beveled butt joints on heavy steel plate; Building-up on cast iron;
   Brazing beveled joints on cast iron;
   Silver soldering nonferrous metals; and,
   Silver soldering ferrous and nonferrous metals.

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Welding Series
STUDENT LABORATORY MANUAL
DUTIES L1 THROUGH U

2565

Supported by the National Science Foundation's Advanced Technological Education Program

WELDER ...that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties ← **Tasks** →

A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDs.F16
07/1994

Duty L1

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
M2 GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3 GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1 Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2 Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-L1-HO1
Preheat Joint
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Outline safety rules for ARC Welding;
B. Properly adjust machine settings;
C. Understand basis of striking the arc electrode manipulation, and evaluating the puddle;
D. Apply the use of gas to preheat joint on mild steel plate;
E. Apply the pre-heating technique using Electrodes; and,
F. Discuss the use of other ways of preheating (Blankets, etc.).

MODULE OUTLINE:

Instructor Topics:

A. Discuss the principles and theories involved in SMAW operations
B. Emphasize safety rules for ARC Welding equipment
C. Demonstrate machine settings and basis of striking the Arc
D. Electrode manipulation and reading the puddle
E. Demonstrate knowledge of joint design and welding terms
F. Demonstrate ability to interpret drawings and blueprints, using weld symbols
G. Introduce welding variables and demonstrate their effects on weld quality
H. Demonstrate knowledge of adequate preparation of welding surfaces
I. Prepare butt joints, and tee joints, for welding
J. Increase knowledge of current industry standards and techniques
K. Identify polarity requirements using SMAW on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match SMAW electrodes to an appropriate base metal

Student Activities:

A. Demonstrate knowledge of safety rules
B. Demonstrate equipment operation and setting adjustments
C. Preheat weld surface
D. Prepare and task weld coupons
E. Understand D.C. straight and reverse polarity

WLD-L1-HO2
Preheat Joint
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
  A. Hardening for utility
  B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  A. Brine (water and sodium chloride or sodium hydroxide)
  B. Water
  C. Fused (liquid) salts
  D. Molten lead
  E. Soluble oil and water
  F. Oil
  G. Air
IV. Estimate Metal Heat Temperature by Color
  A. Use of temper color chart for tempering
  B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

- V. List Reasons for Stress Relieving Workpieces
  - A. Increased machinability
  - B. Increased workability in cold processes
- VI. Special Safety Concerns of Heat Treating
  - A. Protective Gear against . . .
    - 1. Heat
    - 2. Fumes
    - 3. Concussion
  - B. Toxicity of Certain Media
- VII. Special Problems in Heat Treating
  - A. Brittleness
  - B. Distortion
  - C. Discoloration (sometimes unimportant)
  - D. Inadvertent heat treating

WLD-L1-HO3

Preheat Joint

Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Perform file test to test for metal hardness;
- b. Use other tests to identify metals; and,
- c. Perform Rockwell hardness tests.

MODULE OUTLINE:

- I. Perform File Test to Test for Metal Hardness
  - A. Imprecise method, good for rough estimates only
  - B. Requires more experienced machinist
- II. Use Other Tests to Identify Metals
  - A. High-carbon steels show more spark bursts than do low-carbon steels.
  - B. Non-ferrous metals
    - 1. Aluminum
    - 2. Magnesium
    - 3. Brass
    - 4. Bronze
    - 5. Nickel
    - 6. Tin
    - 7. Others
- III. Perform Rockwell Hardness Tests
  - A. Ferrous metals
  - B. Non-ferrous metals
- IV. Perform Brinell Hardness Tests
  - A. Ferrous metals
  - B. Non-ferrous metals
- V. Other Hardness Tests as Specified by the Instructor
  - A. Ferrous metals
  - B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L1-HO4
Preheat Joint
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

    c. Verbally warn others of intent to arc weld
    d. Strike an arc
    e. Weld with stringer bead technique
    f. Perform weld tie ins to make continuous bead
7. Weld Using Weave Technique
    a. Maintain required weld quality
    b. Maintain proper weld width uniformly
    c. Maintain proper travel speed
    d. Match correct oscillation for various electrodes
    e. Match applications to weave techniques, as they apply
    f. List the advantages and disadvantages of weave techniques
    g. List the advantages and disadvantages of stringer techniques
    h. Perform weld using weave technique
    i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
    a. Weld a dam to outline area being welded for each layer
    b. Apply each layer neatly, straight and with good fusion throughout
    c. Chip slag after each pass
    d. Weld passes which over lap to crown of last weld bead
    e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
    a. Follow manufacturer's recommended practice
    b. Inspect equipment and work area for safety
    c. Assemble oxy-fuel equipment
    d. Open fuel gas cylinder ½ turn
    e. Open oxygen as cylinder all the way
    f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
    g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    a. Make manual free hand straight line cuts
    b. Cut manually straight lines using cutting jib
    c. Bevel plate with manual oxy-fuel equipment
    d. Manually cut blind holes in thick material
    e. Manually cut sheet metal with minimal distortion

WLD-L1-HO5
Preheat Joint
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
h. Chip slag and wire brush weld
i. Grind any lack of fusion and/or high spots
j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
k. Visually inspect weld on the root and face sides to ASME Section 9
l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
a. Measure the pipe
b. Mark the cut line with a wrap around and soapstone
c. Cut the bevel using oxy-fuel gas equipment
d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
e. Use the grinder to add a root face of from 3/32" to 1/8"
f. Tack the single V groove pipe joint with a 3/32" root opening
g. Weld pipe joint
h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
k. Visually inspect weld on the root and face sides to ASME Section 9
l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Roll Weld Pipe - SMAW
a. Measure the pipe
b. Mark the cut line with a wrap around and soapstone
c. Cut the bevel using oxy-fuel gas equipment
d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
e. Use the grinder to add a root face of from 3/32" to 1/8"
f. Tack the single V groove pipe joint with a 3/32" root opening
g. Roll weld pipe
h. Place pipe coupon on workbench in the 1G roll welding position.
i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
l. Visually inspect weld on the root and face sides to ASME Section 9
m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
    a. Measure the pipe and
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Weld pipe
    g. Tack the single V groove pipe joint with a 3/32" root opening
    h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
    i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    l. Visually inspect weld on the root and face sides to ASME Section 9
    m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
7. Produce SMAW Pipe - 6G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
    h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L1-HO6
Preheat Joint
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
   a. Produce end preparations with oxy-fuel cutting
   b. Produce end preparations with plasma cutting
   c. Produce end preparations with mechanical cutting
   d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
   a. Cut and single bevel pipe to 37 1/2°
   b. Ground bevel face and touch up to within tolerances
   c. Check that pipe ends are square within given tolerances
   d. Prepare root face within given tolerances
   e. Align pipe to within given tolerances
   f. Set root opening to within given tolerances
   g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
   a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   b. Weld remainder of pipe in the 1G roll welding position with E6010
   c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   a. Weld using 1/8" E6010
   b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   d. Weld root pass to ASME Section 9 requirements
   e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
   a. Fit and tack weld pipe to within tolerances
   b. Place pipe in the 5G position
   c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
   d. Grind the finished root pass to remove high spots and any slag at weld toes

   - e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   - a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   - b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   - c. Weld remainder of pipe in 1G position using E7018
   - d. Perform low hydrogen starts and stops
   - e. Weld using stringer bead technique
   - f. Weld using weave technique
   - g Chip slag wire brush and grind as necessary to assure clean weld deposits

7. Weld Open Root Pipe - 2G Position
   - a. Use 1/8" E6010
   - b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   - c. Fit together two pipe ends to a single V edge preparation within given tolerances
   - c. Weld root pass to ASME Section 9 requirements
   - d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   - e. Weld remainder of the groove using E7018 with the stringer bead technique

8. Weld Pipe Open Root Passes All Positions Using GMAW
   - a. Set up GMAW equipment
   - b. Adjust wire feeder drive system
   - c. Adjust shielding gas system and flow rate
   - d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   - e. Set welding condition for short circuit transfer - Wire Feed Speed
   - f. Set welding condition for short circuit transfer - Voltage
   - g. Set welding condition for short circuit transfer - Tip to work Distance
   - h. Weld root using a string bead technique

9. Weld Pipe With Backing Using FCAW-G
   - a. Bevel pipe ends
   - b. Touch up bevel face with grinder
   - c. Fit and tack backing ring to one pipe end
   - d. Fit other pipe over backing ring
   - e. Adjust gap and tack in place
   - f. Adjust shielding gas flow
   - g. Adjust wire feed system
   - h. Adjust power source to procedure specification
   - i. Set wire feed speed to procedure specification
   - j. Adjust voltage to procedure specification
   - k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L1-LA
Preheat Joint
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L1-LW
Preheat Joint
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. Choose Proper Power Source

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. Choose a Proper Electrode

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current
DC+(DCRP) Direct Current Reverse Polarity
DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

    - (1) Product design
    - (2) Material thickness
    - (3) Design strength requirements
    - (4) Welding process employed
  - b. SMAW weld joint configuration may be a:
    - (1) Lap joint
    - (2) Tee joint
    - (3) Corner joint
    - (4) Edge joint
    - (5) Butt joint with backing
    - (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
  - a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
  - b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
  - a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
  - b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
  - c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.
b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:
  a. Type of electrode
  b. Diameter of electrode
  c. Type of current (AC or DC)
  d. Current polarity (DC+ or DC-)
  e. Current setting
  f. Arc length
  g. Travel speed
  h. Electrode angle
  i. Electromagnetic arc blow
  j. Electrode manipulation technique (drag, whip)
  k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:
  a. Type of base metal
  b. Thickness of base metal
  c. Surface condition of base metal (clean, rusty, or painted)
  d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

WLD-L2-HO1
Initiate Welding Process
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Apply the use of gas to preheat joint on mild steel plate;
B. Weld Pad of Beads, flat position with 6010 Electrodes, (Weave and Stringer);
C. Weld Pad of Beads (stringer), plate in vertical position, horizontal travel sing 6010 Electrodes;
D. Weld Pad of Beads (stringer), plate in vertical position, vertical travel using 6010 Electrodes;
E. Weld Pad of Beads (stringer) overhead position using 6010 Electrodes;
F. Fillet weld Multi-Stringer, horizontal travel using 6010 Electrodes;
G. Fillet weld Multi-Stringer, vertical travel using 6010 Electrodes;
H. Fillet weld Multi-Stringer, overhead using 6010 Electrodes;
I. Weld Open groove, Multi-Stringer, horizontal position using 6010 Electrodes;
J. Weld Open groove, Multi-Stringer, vertical position using 6010 Electrodes;
K. Weld Open groove, overhead position using 6010 Electrodes;
L. Weld Open groove, vertical position, 6010 root pass 7018 fill & cap;
M. Weld Open groove, overhead position 6010 root pass 7018 fill & cap; and,
N. Perform destructive testing on weld samples to determine discontinuities and proficiency.

MODULE OUTLINE:

Instructor Topics:

A. Emphasize the principles involved in the operating of SMAW equipment
B. Discuss fundamentals of joint design and relevance of welding terms
C. How to interpret drawings and blueprints, using SMAW
D. Demonstration of the proper application of welding skills
E. Demonstration of adequate preparation of welding surfaces
F. Prepare butt joints, and tee joints, for welding
G. Identify polarity requirements using SMAW on various metals
H. Demonstrate preheat and how to maintain desired temperature
I. Match SMAW electrodes to an appropriate base metal
J. Demonstrate SMAW in the flat horizontal, vertical, and overhead positions
K. Identify welding variables and their effects on weld quality
L. Increase knowledge of current industry standards and techniques
M. Increase skill level to pass certification tests
N. Identify the AISI steel classification system

Student Activities:

A. Preheat weld surface

B. Perform welds in multiple positions
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality
F. Perform destruction testing on weld samples

WLD-L2-HO2
Initiate Welding Process
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
    A. Hardening for utility
    B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
    A. Brine (water and sodium chloride or sodium hydroxide)
    B. Water
    C. Fused (liquid) salts
    D. Molten lead
    E. Soluble oil and water
    F. Oil
    G. Air
IV. Estimate Metal Heat Temperature by Color
    A. Use of temper color chart for tempering
    B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
A. Increased machinability
B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
A. Protective Gear against . . .
1. Heat
2. Fumes
3. Concussion
B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
A. Brittleness
B. Distortion
C. Discoloration (sometimes unimportant)
D. Inadvertent heat treating

WLD-L2-HO3
Initiate Welding Process
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
    A. Imprecise method, good for rough estimates only
    B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
    A. High-carbon steels show more spark bursts than do low-carbon steels.
    B. Non-ferrous metals
        1. Aluminum
        2. Magnesium
        3. Brass
        4. Bronze
        5. Nickel
        6. Tin
        7. Others
III. Perform Rockwell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
    A. Ferrous metals
    B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L2-HO4
Initiate Welding Process
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

   - c. Verbally warn others of intent to arc weld
   - d. Strike an arc
   - e. Weld with stringer bead technique
   - f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
   - a. Maintain required weld quality
   - b. Maintain proper weld width uniformly
   - c. Maintain proper travel speed
   - d. Match correct oscillation for various electrodes
   - e. Match applications to weave techniques, as they apply
   - f. List the advantages and disadvantages of weave techniques
   - g. List the advantages and disadvantages of stringer techniques
   - h. Perform weld using weave technique
   - i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   - a. Weld a dam to outline area being welded for each layer
   - b. Apply each layer neatly, straight and with good fusion throughout
   - c. Chip slag after each pass
   - d. Weld passes which over lap to crown of last weld bead
   - e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   - a. Follow manufacturer's recommended practice
   - b. Inspect equipment and work area for safety
   - c. Assemble oxy-fuel equipment
   - d. Open fuel gas cylinder ½ turn
   - e. Open oxygen as cylinder all the way
   - f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   - g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    - a. Make manual free hand straight line cuts
    - b. Cut manually straight lines using cutting jib
    - c. Bevel plate with manual oxy-fuel equipment
    - d. Manually cut blind holes in thick material
    - e. Manually cut sheet metal with minimal distortion

WLD-L2-HO5
Initiate Welding Process
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

   g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   h. Chip slag and wire brush weld
   i. Grind any lack of fusion and/or high spots
   j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
4. Produce SMAW - 2G Position Groove Welds
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Weld pipe joint
   h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Roll weld pipe
   h. Place pipe coupon on workbench in the 1G roll welding position.
   i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9

l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
   a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
   b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
   c. Set welding condition to weld open roots
   d. Tack pipe nipples together to form a V groove with a 1/8" root opening
   e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
   f. Weld balance of the V groove with this procedure
   g. Visual inspection is made and evaluated by ASME Section 9
   h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
   a. Identify process
   b. Name joint design
   c. List base material
   d. Give dimensions for root treatment
   e. Name electrode size and type being used
   f. List filler material (if required), classification and specification
   g. Identify shielding gas - type and mixture
   h. List pre and post heat and interpass temperature
   i. Describe initial and interpass cleaning
   j. Describe technique which is used
   k. Produce single or multiple pass weld
   l. Choose current type
   m. Set current amperage
   n. Set current polarity
   o. Set voltage

WLD-L2-HO6
Initiate Welding Process
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    a. Produce end preparations with oxy-fuel cutting
    b. Produce end preparations with plasma cutting
    c. Produce end preparations with mechanical cutting
    d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    a. Cut and single bevel pipe to 37 1/2°
    b. Ground bevel face and touch up to within tolerances
    c. Check that pipe ends are square within given tolerances
    d. Prepare root face within given tolerances
    e. Align pipe to within given tolerances
    f. Set root opening to within given tolerances
    g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    b. Weld remainder of pipe in the 1G roll welding position with E6010
    c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    a. Weld using 1/8" E6010
    b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    d. Weld root pass to ASME Section 9 requirements
    e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    a. Fit and tack weld pipe to within tolerances
    b. Place pipe in the 5G position
    c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
    d. Grind the finished root pass to remove high spots and any slag at weld toes

    e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
    a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
    b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
    c. Weld remainder of pipe in 1G position using E7018
    d. Perform low hydrogen starts and stops
    e. Weld using stringer bead technique
    f. Weld using weave technique
    g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
    a. Use 1/8" E6010
    b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
    c. Fit together two pipe ends to a single V edge preparation within given tolerances
    c. Weld root pass to ASME Section 9 requirements
    d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
    e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
    a. Set up GMAW equipment
    b. Adjust wire feeder drive system
    c. Adjust shielding gas system and flow rate
    d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
    e. Set welding condition for short circuit transfer - Wire Feed Speed
    f. Set welding condition for short circuit transfer - Voltage
    g. Set welding condition for short circuit transfer - Tip to work Distance
    h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
    a. Bevel pipe ends
    b. Touch up bevel face with grinder
    c. Fit and tack backing ring to one pipe end
    d. Fit other pipe over backing ring
    e. Adjust gap and tack in place
    f. Adjust shielding gas flow
    g. Adjust wire feed system
    h. Adjust power source to procedure specification
    i. Set wire feed speed to procedure specification
    j. Adjust voltage to procedure specification
    k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L2-LA
Initiate Welding Process
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L2-LW
Initiate Welding Process
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**

   Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

   Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

   Step 1. Choose the proper electrode for the job.

   NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

   The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

   Step 2. Store the electrodes properly.

   a. Low-hydrogen electrodes:

   (1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

   (2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

   (3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

   NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC	Alternating Current
DC+(DCRP)	Direct Current Reverse Polarity
DC-(DCSP)	Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

        - (1) Product design
        - (2) Material thickness
        - (3) Design strength requirements
        - (4) Welding process employed
    - b. SMAW weld joint configuration may be a:
        - (1) Lap joint
        - (2) Tee joint
        - (3) Corner joint
        - (4) Edge joint
        - (5) Butt joint with backing
        - (6) Butt joint without backing

- Step 2. Clean the areas to be welded prior to fit-up
    - a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
    - b. Remove oils and greases with a safe, suitable solvent
- Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.
- Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.
- Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

- Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.
- Step 2. Use any preheat that may be required by welding codes or company procedures.
- Step 3. Make the required weld to be defect free and pleasing in appearance.
- Step 4. Use proper weld bead placement according to the weld joint design.
    - a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
    - b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
    - c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.
- Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

- a. Type of electrode
- b. Diameter of electrode
- c. Type of current (AC or DC)
- d. Current polarity (DC+ or DC-)
- e. Current setting
- f. Arc length
- g. Travel speed
- h. Electrode angle
- i. Electromagnetic arc blow
- j. Electrode manipulation technique (drag, whip)
- k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

- a. Type of base metal
- b. Thickness of base metal
- c. Surface condition of base metal (clean, rusty, or painted)
- d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

WLD-L3-HO1
Perform Weld Sequence
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- A. Weld Multi-Stringer beads on steel plate using E6010 & E7018;
- B. Weld steel plate using weave technique with E6010 & E7018; and,
- C. Weld steel plate with E6010 for a root pass and E7018 fill & cap.

PRESENTATION OUTLINE:

Instructor Topics:

- A. Emphasizes the principles involved in the operating of SMAW equipment
- B. Demonstrate knowledge of the proper application of welding skills and techniques
- C. Illustrate welding techniques for the five basic welding joints
- D. Demonstrate knowledge of adequate preparation of welding surfaces
- E. Demonstrate preheat and how to maintain desired temperature
- F. Identify welding variables and their effects on weld quality
- G. Identify the AISI steel classification system
- H. Match SMAW electrodes to an appropriate base metal
- I. Illustrate quality weld techniques for SMAW in student exercises

Student Activities:

- A. Preheat weld surface
- B. Weld multiple stringer beads
- C. Use weave technique
- D. Use oscillating and non-oscillating welding technique
- E. Perform single pass and multi-pass welds;
    1. Flat plate, stringer bead, flat position;
    2. Lap joint, Fillet weld, flat position;
    3. Edge, Stringer bead, flat position;
    4. Flat plate, Pad stinger bead, Horizontal position;
    5. Lap, Fillet weld, Vertical down position;
    6. Lap, Fillet weld, Horizontal position;
    7. "T", Multipass weave beads, Flat position;
    8. Single "Y" butt, Multipass Groove weld, horizontal position;
    9. Coupling, Fillet weld, Horizontal position;
    10. Single "V" butt, Multipass filler weld, Overhead position;
    11. Square butt, Bead groove weld, Overhead position;
    12. Single "V" butt, Multipass groove weld, Horizontal position;
    13. Single "V" butt, Multipass groove weld, Overhead position.

WLD-L3-HO2
Perform Weld Sequence
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- a. Discuss the reasons for heat treating;
- b. Discuss the time/temperature chart
- c. List the different quenching media
- d. Estimate metal heat temperature by color; and
- e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

- I. Discuss the Reasons for Heat Treating
  - A. Hardening for utility
  - B. Tempering for toughness without brittleness
- II. Discuss the Time/Temperature Chart
- III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  - A. Brine (water and sodium chloride or sodium hydroxide)
  - B. Water
  - C. Fused (liquid) salts
  - D. Molten lead
  - E. Soluble oil and water
  - F. Oil
  - G. Air
- IV. Estimate Metal Heat Temperature by Color
  - A. Use of temper color chart for tempering
  - B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
    A. Increased machinability
    B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
    A. Protective Gear against . . .
        1. Heat
        2. Fumes
        3. Concussion
    B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
    A. Brittleness
    B. Distortion
    C. Discoloration (sometimes unimportant)
    D. Inadvertent heat treating

WLD-L3-HO3
Perform Weld Sequence
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. **Perform file test to test for metal hardness;**
b. **Use other tests to identify metals; and,**
c. **Perform Rockwell hardness tests.**

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
  A. Imprecise method, good for rough estimates only
  B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
  A. High-carbon steels show more spark bursts than do low-carbon steels.
  B. Non-ferrous metals
   1. Aluminum
   2. Magnesium
   3. Brass
   4. Bronze
   5. Nickel
   6. Tin
   7. Others
III. Perform Rockwell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
  A. Ferrous metals
  B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L3-HO4
Perform Weld Sequence
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

   c. Verbally warn others of intent to arc weld
   d. Strike an arc
   e. Weld with stringer bead technique
   f. Perform weld tie ins to make continuous bead
7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
   a. Make manual free hand straight line cuts
   b. Cut manually straight lines using cutting jib
   c. Bevel plate with manual oxy-fuel equipment
   d. Manually cut blind holes in thick material
   e. Manually cut sheet metal with minimal distortion

WLD-L3-HO5
Perform Weld Sequence
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
h. Chip slag and wire brush weld
i. Grind any lack of fusion and/or high spots
j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
k. Visually inspect weld on the root and face sides to ASME Section 9
l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Weld pipe joint
   h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Roll weld pipe
   h. Place pipe coupon on workbench in the 1G roll welding position.
   i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

    k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    l. Visually inspect weld on the root and face sides to ASME Section 9
    m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
    a. Measure the pipe and
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Weld pipe
    g. Tack the single V groove pipe joint with a 3/32" root opening
    h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
    i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    l. Visually inspect weld on the root and face sides to ASME Section 9
    m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
7. Produce SMAW Pipe - 6G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
    h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9

   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
   a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
   b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
   c. Set welding condition to weld open roots
   d. Tack pipe nipples together to form a V groove with a 1/8" root opening
   e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
   f. Weld balance of the V groove with this procedure
   g. Visual inspection is made and evaluated by ASME Section 9
   h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
   a. Identify process
   b. Name joint design
   c. List base material
   d. Give dimensions for root treatment
   e. Name electrode size and type being used
   f. List filler material (if required), classification and specification
   g. Identify shielding gas - type and mixture
   h. List pre and post heat and interpass temperature
   i. Describe initial and interpass cleaning
   j. Describe technique which is used
   k. Produce single or multiple pass weld
   l. Choose current type
   m. Set current amperage
   n. Set current polarity
   o. Set voltage

WLD-L3-HO6
Perform Weld Sequence
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    a. Produce end preparations with oxy-fuel cutting
    b. Produce end preparations with plasma cutting
    c. Produce end preparations with mechanical cutting
    d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    a. Cut and single bevel pipe to 37 1/2°
    b. Ground bevel face and touch up to within tolerances
    c. Check that pipe ends are square within given tolerances
    d. Prepare root face within given tolerances
    e. Align pipe to within given tolerances
    f. Set root opening to within given tolerances
    g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    b. Weld remainder of pipe in the 1G roll welding position with E6010
    c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    a. Weld using 1/8" E6010
    b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    d. Weld root pass to ASME Section 9 requirements
    e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    a. Fit and tack weld pipe to within tolerances
    b. Place pipe in the 5G position
    c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
    d. Grind the finished root pass to remove high spots and any slag at weld toes

   e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements
6. Pass Guided Bond Tests Per ASME Section 9
   a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   c. Weld remainder of pipe in 1G position using E7018
   d. Perform low hydrogen starts and stops
   e. Weld using stringer bead technique
   f. Weld using weave technique
   g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   a. Use 1/8" E6010
   b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   c. Fit together two pipe ends to a single V edge preparation within given tolerances
   c. Weld root pass to ASME Section 9 requirements
   d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
   a. Set up GMAW equipment
   b. Adjust wire feeder drive system
   c. Adjust shielding gas system and flow rate
   d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   e. Set welding condition for short circuit transfer - Wire Feed Speed
   f. Set welding condition for short circuit transfer - Voltage
   g. Set welding condition for short circuit transfer - Tip to work Distance
   h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
   a. Bevel pipe ends
   b. Touch up bevel face with grinder
   c. Fit and tack backing ring to one pipe end
   d. Fit other pipe over backing ring
   e. Adjust gap and tack in place
   f. Adjust shielding gas flow
   g. Adjust wire feed system
   h. Adjust power source to procedure specification
   i. Set wire feed speed to procedure specification
   j. Adjust voltage to procedure specification
   k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

*** As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.**

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.
D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.
E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.
F. Do not weld on materials having either a coating or internal structure that is combustible.
G. Place hot scrap and slag in non-combustible containers.
H. Ensure that fire extinguishers are available nearby.
I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.
J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: **NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.**
DON'T CARRY A BOMB IN YOUR POCKET.

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current
DC+(DCRP) Direct Current Reverse Polarity
DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

(1) Product design
(2) Material thickness
(3) Design strength requirements
(4) Welding process employed

b. SMAW weld joint configuration may be a:
(1) Lap joint
(2) Tee joint
(3) Corner joint
(4) Edge joint
(5) Butt joint with backing
(6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

- a. As the material thickness increases, the travel speed must slow down.
- b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
- c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

- a. Type of electrode
- b. Diameter of electrode
- c. Type of current (AC or DC)
- d. Current polarity (DC+ or DC-)
- e. Current setting
- f. Arc length
- g. Travel speed
- h. Electrode angle
- i. Electromagnetic arc blow
- j. Electrode manipulation technique (drag, whip)
- k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

- a. Type of base metal
- b. Thickness of base metal
- c. Surface condition of base metal (clean, rusty, or painted)
- d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

WLD-L4-HO1
Control Weld Technique
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Use proper welding techniques for light gage metals;
B. Demonstrate proper methods of welding materials of different thickness into a lap joint;
C. Use iron powder or heavy coated electrodes, understand the use and advantage of low hydrogen electrodes; and,
D. Control movement pattern and width of each bead on the overhead position Tee joint using low hydrogen electrodes.

MODULE OUTLINE:

Instructor Topics:

A. Welding technique for light gage metals
B. Proper methods of welding metals of different thickness into a lap joint
C. Use of iron powder or heavy coated electrodes
D. The advantages of low hydrogen electrodes and its applications
E. Proper manipulation of the low hydrogen electrode to make a sound multipass filler in the vertical position
F. To teach control of the movement pattern and width of each bead on the overhead position tee joint, using low hydrogen electrodes
G. To teach the ability to adjust current while welding sheet steel

Student Activities:

Perform the following:

A. Fillet Weld, Lap and Tee Joints Flat and Vertical
B. Fillet Weld, Lap Joint, Vertical Down Position
C. Fillet Weld, Lap Joint, Horizontal Position
D. Fillet Weld, Tee Joint, Vertical Up Position
E. Fillet Weld, Tee Joint, Overhead Position
F. Adjust current while welding sheet steel

WLD-L4-HO2
Control Weld Technique
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
    A. Hardening for utility
    B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
    A. Brine (water and sodium chloride or sodium hydroxide)
    B. Water
    C. Fused (liquid) salts
    D. Molten lead
    E. Soluble oil and water
    F. Oil
    G. Air
IV. Estimate Metal Heat Temperature by Color
    A. Use of temper color chart for tempering
    B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes

VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media

VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L4-HO3
Control Weld Technique
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
    A. Imprecise method, good for rough estimates only
    B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
    A. High-carbon steels show more spark bursts than do low-carbon steels
    B. Non-ferrous metals
        1. Aluminum
        2. Magnesium
        3. Brass
        4. Bronze
        5. Nickel
        6. Tin
        7. Others
III. Perform Rockwell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
    A. Ferrous metals
    B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L4-HO4
Control Weld Technique
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018.
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

   c. Verbally warn others of intent to arc weld
   d. Strike an arc
   e. Weld with stringer bead technique
   f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
   a. Make manual free hand straight line cuts
   b. Cut manually straight lines using cutting jib
   c. Bevel plate with manual oxy-fuel equipment
   d. Manually cut blind holes in thick material
   e. Manually cut sheet metal with minimal distortion

WLD-L4-HO5

Control Weld Technique

Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

  g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
  h. Chip slag and wire brush weld
  i. Grind any lack of fusion and/or high spots
  j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
  k. Visually inspect weld on the root and face sides to ASME Section 9
  l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Weld pipe joint
   h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Roll Weld Pipe - SMAW
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Roll weld pipe
   h. Place pipe coupon on workbench in the 1G roll welding position.
   i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique

l. Visually inspect weld on the root and face sides to ASME Section 9

m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position

a. Measure the pipe and

b. Mark the cut line with a wrap around and soapstone

c. Cut the bevel using oxy-fuel gas equipment

d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face

e. Use the grinder to add a root face of from 3/32" to 1/8"

f. Weld pipe

g. Tack the single V groove pipe joint with a 3/32" root opening

h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique

i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate

j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique

l. Visually inspect weld on the root and face sides to ASME Section 9

m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position

a. Measure the pipe

b. Mark the cut line with a wrap around and soapstone

c. Cut the bevel using oxy-fuel gas equipment

d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face

e. Use the grinder to add a root face of from 3/32" to 1/8"

f. Tack the single V groove pipe joint with a 3/32" root opening

g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique

h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate

i. Chip slag and wire brush. Grind any lack of fusion and/or high spots

j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique

k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L4-HO6
Control Weld Technique
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    a. Produce end preparations with oxy-fuel cutting
    b. Produce end preparations with plasma cutting
    c. Produce end preparations with mechanical cutting
    d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    a. Cut and single bevel pipe to 37 1/2°
    b. Ground bevel face and touch up to within tolerances
    c. Check that pipe ends are square within given tolerances
    d. Prepare root face within given tolerances
    e. Align pipe to within given tolerances
    f. Set root opening to within given tolerances
    g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    b. Weld remainder of pipe in the 1G roll welding position with E6010
    c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    a. Weld using 1/8" E6010
    b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    d. Weld root pass to ASME Section 9 requirements
    e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    a. Fit and tack weld pipe to within tolerances
    b. Place pipe in the 5G position
    c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
    d. Grind the finished root pass to remove high spots and any slag at weld toes

e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   c. Weld remainder of pipe in 1G position using E7018
   d. Perform low hydrogen starts and stops
   e. Weld using stringer bead technique
   f. Weld using weave technique
   g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   a. Use 1/8" E6010
   b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   c. Fit together two pipe ends to a single V edge preparation within given tolerances
   c. Weld root pass to ASME Section 9 requirements
   d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
   a. Set up GMAW equipment
   b. Adjust wire feeder drive system
   c. Adjust shielding gas system and flow rate
   d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   e. Set welding condition for short circuit transfer - Wire Feed Speed
   f. Set welding condition for short circuit transfer - Voltage
   g. Set welding condition for short circuit transfer - Tip to work Distance
   h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
   a. Bevel pipe ends
   b. Touch up bevel face with grinder
   c. Fit and tack backing ring to one pipe end
   d. Fit other pipe over backing ring
   e. Adjust gap and tack in place
   f. Adjust shielding gas flow
   g. Adjust wire feed system
   h. Adjust power source to procedure specification
   i. Set wire feed speed to procedure specification
   j. Adjust voltage to procedure specification
   k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

Worksheet:

1. Choose Proper Power Source

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. Choose a Proper Electrode

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC	Alternating Current
DC+(DCRP)	Direct Current Reverse Polarity
DC-(DCSP)	Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

        (1) Product design
        (2) Material thickness
        (3) Design strength requirements
        (4) Welding process employed
    b. SMAW weld joint configuration may be a:
        (1) Lap joint
        (2) Tee joint
        (3) Corner joint
        (4) Edge joint
        (5) Butt joint with backing
        (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
    a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
    b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
    a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
    b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
    c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

   - a. As the material thickness increases, the travel speed must slow down.
   - b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
   - c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

   - a. Type of electrode
   - b. Diameter of electrode
   - c. Type of current (AC or DC)
   - d. Current polarity (DC+ or DC-)
   - e. Current setting
   - f. Arc length
   - g. Travel speed
   - h. Electrode angle
   - i. Electromagnetic arc blow
   - j. Electrode manipulation technique (drag, whip)
   - k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

   - a. Type of base metal
   - b. Thickness of base metal
   - c. Surface condition of base metal (clean, rusty, or painted)
   - d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

WLD-L5-HO1
Maintain Preheat and Perform Interpass
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Weld carbon steels using the SMAW process;
B. Apply large fillet welds in multiple position on thick material;
C. Perform weave bead techniques for making large welds; and,
D. Understand and practice the methods of destructive testing.

MODULE OUTLINE:

Instructor Topics:

A. Develop skill in repositioning large fillet welds in the horizontal position on thick material
B. Provide practice in multiple pass welding on heavy workpieces
C. Provide an orientation to the requirements of welding codes as they apply to the qualification of welders and procedures
D. Provide practice in weave bead technique for making large welds
E. Define destructive testing and present a brief description of the different methods of destructive testing

Student Activities:

A. Perform multiple pass welding on heavy workpieces; Fillet Weld, Lap Joint, Horizontal Position (21 Bead)
B. Perform welds using 6 bead and 3-45^0 weaves: Fillet Weld, Lap Joint, Overhead Position
C. Practice weave bead technique for making large welds, Fillet Weld, Lap Joint, Vertical Position (Uphill)
D. Make adjustments to improve weld quality
E. Perform destructive testing

WLD-L5-HO2
Maintain Preheat and Perform Interpass
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
    A. Hardening for utility
    B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
    A. Brine (water and sodium chloride or sodium hydroxide)
    B. Water
    C. Fused (liquid) salts
    D. Molten lead
    E. Soluble oil and water
    F. Oil
    G. Air
IV. Estimate Metal Heat Temperature by Color
    A. Use of temper color chart for tempering
    B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

- V. List Reasons for Stress Relieving Workpieces
  - A. Increased machinability
  - B. Increased workability in cold processes
- VI. Special Safety Concerns of Heat Treating
  - A. Protective Gear against . . .
    - 1. Heat
    - 2. Fumes
    - 3. Concussion
  - B. Toxicity of Certain Media
- VII. Special Problems in Heat Treating
  - A. Brittleness
  - B. Distortion
  - C. Discoloration (sometimes unimportant)
  - D. Inadvertent heat treating

WLD-L5-HO3
Maintain Preheat and Perform Interpass
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
    A. Imprecise method, good for rough estimates only
    B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
    A. High-carbon steels show more spark bursts than do low-carbon steels.
    B. Non-ferrous metals
        1. Aluminum
        2. Magnesium
        3. Brass
        4. Bronze
        5. Nickel
        6. Tin
        7. Others
III. Perform Rockwell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
    A. Ferrous metals
    B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L5-HO4

Maintain Preheat and Perform Interpass

Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    - a. Define arc welding process terms
    - b. Define standard joint terminology
    - c. Define common weld discontinuities
    - d. Name welding equipment, supply and consumables
    - e. Define common shop terms including proper equipment names
    - f. Define material terms
    - g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    - a. List, describe and define
    - b. List low hydrogen electrodes
    - c. List iron powder electrodes
    - d. Describe electrode by welding position
    - e. Describe electrode by current and polarity
    - f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    - a. List polarities for commonly used electrodes
    - b. Describe both polarities
    - c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    - a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    - b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    - c. List reasons for the importance of low hydrogen in weld metal
    - d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    - a. Inspect area for safety
    - b. Adjust current and polarity for specific job requirements
    - c. Choose type and size of electrode
    - d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    - a. Stand and position oneself correctly
    - b. Operate welding helmet

   c. Verbally warn others of intent to arc weld
   d. Strike an arc
   e. Weld with stringer bead technique
   f. Perform weld tie ins to make continuous bead
7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
   a. Make manual free hand straight line cuts
   b. Cut manually straight lines using cutting jib
   c. Bevel plate with manual oxy-fuel equipment
   d. Manually cut blind holes in thick material
   e. Manually cut sheet metal with minimal distortion

WLD-L5-HO5
Maintain Preheat and Perform Interpass
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

   g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   h. Chip slag and wire brush weld
   i. Grind any lack of fusion and/or high spots
   j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Weld pipe joint
   h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Roll Weld Pipe - SMAW
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Roll weld pipe
   h. Place pipe coupon on workbench in the 1G roll welding position.
   i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

    k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    l. Visually inspect weld on the root and face sides to ASME Section 9
    m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
    a. Measure the pipe and
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Weld pipe
    g. Tack the single V groove pipe joint with a 3/32" root opening
    h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
    i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    l. Visually inspect weld on the root and face sides to ASME Section 9
    m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
    h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9

    - l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
8. Create SMAW Pipe to ASME Section 9
    - a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    - b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    - c. Set welding condition to weld open roots
    - d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    - e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    - f. Weld balance of the V groove with this procedure
    - g. Visual inspection is made and evaluated by ASME Section 9
    - h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    - a. Identify process
    - b. Name joint design
    - c. List base material
    - d. Give dimensions for root treatment
    - e. Name electrode size and type being used
    - f. List filler material (if required), classification and specification
    - g. Identify shielding gas - type and mixture
    - h. List pre and post heat and interpass temperature
    - i. Describe initial and interpass cleaning
    - j. Describe technique which is used
    - k. Produce single or multiple pass weld
    - l. Choose current type
    - m. Set current amperage
    - n. Set current polarity
    - o. Set voltage

WLD-L5-HO6

Maintain Preheat and Perform Interpass

Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
   - a. Produce end preparations with oxy-fuel cutting
   - b. Produce end preparations with plasma cutting
   - c. Produce end preparations with mechanical cutting
   - d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
   - a. Cut and single bevel pipe to 37 1/2°
   - b. Ground bevel face and touch up to within tolerances
   - c. Check that pipe ends are square within given tolerances
   - d. Prepare root face within given tolerances
   - e. Align pipe to within given tolerances
   - f. Set root opening to within given tolerances
   - g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
   - a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   - b. Weld remainder of pipe in the 1G roll welding position with E6010
   - c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   - a. Weld using 1/8" E6010
   - b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   - c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   - d. Weld root pass to ASME Section 9 requirements
   - e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
   - a. Fit and tack weld pipe to within tolerances
   - b. Place pipe in the 5G position
   - c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
   - d. Grind the finished root pass to remove high spots and any slag at weld toes

   e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   c. Weld remainder of pipe in 1G position using E7018
   d. Perform low hydrogen starts and stops
   e. Weld using stringer bead technique
   f. Weld using weave technique
   g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   a. Use 1/8" E6010
   b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   c. Fit together two pipe ends to a single V edge preparation within given tolerances
   c. Weld root pass to ASME Section 9 requirements
   d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
   a. Set up GMAW equipment
   b. Adjust wire feeder drive system
   c. Adjust shielding gas system and flow rate
   d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   e. Set welding condition for short circuit transfer - Wire Feed Speed
   f. Set welding condition for short circuit transfer - Voltage
   g. Set welding condition for short circuit transfer - Tip to work Distance
   h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
   a. Bevel pipe ends
   b. Touch up bevel face with grinder
   c. Fit and tack backing ring to one pipe end
   d. Fit other pipe over backing ring
   e. Adjust gap and tack in place
   f. Adjust shielding gas flow
   g. Adjust wire feed system
   h. Adjust power source to procedure specification
   i. Set wire feed speed to procedure specification
   j. Adjust voltage to procedure specification
   k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	Minimum Shade No.	Suggested Shade*
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: **Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.**

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: **NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.**
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L5-LW
Maintain Preheat and Perform Interpass
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. Choose Proper Power Source

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. Choose a Proper Electrode

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current

DC+(DCRP) Direct Current Reverse Polarity

DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

(1) Product design
(2) Material thickness
(3) Design strength requirements
(4) Welding process employed

b. SMAW weld joint configuration may be a:
(1) Lap joint
(2) Tee joint
(3) Corner joint
(4) Edge joint
(5) Butt joint with backing
(6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. Troubleshoot Welding Problems

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

WLD-L6-HO1

Use the Carbon Arc Process to Cut and Gouge Base Weld Materials

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Cut cast iron with air carbon arc process;
B. Cut carbon steels using shielded metal arc cutting process; and,
C. Gouge carbon steels with air carbon arc process.

MODULE OUTLINE:

Instructor Topics:

A. Cutting cast iron, etc. with air carbon arc process
B. Cutting carbon steels using air carbon arc process
C. Gouging carbon steels with air carbon process
D. Perform interpass preparation

Student Activities:

A. Understand cutting processes for cast iron, and carbon steels
B. Use air carbon arc in cutting and gouging
C. Perform multiple cutting operations
D. Select materials for optimum performance
E. Adjust equipment for performance and quality
F. Practice interpass preparation

WLD-L6-HO2
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
   A. Hardening for utility
   B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
   A. Brine (water and sodium chloride or sodium hydroxide)
   B. Water
   C. Fused (liquid) salts
   D. Molten lead
   E. Soluble oil and water
   F. Oil
   G. Air
IV. Estimate Metal Heat Temperature by Color
   A. Use of temper color chart for tempering
   B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L6-HO3

Use the Carbon Arc Process to Cut and Gouge Base Weld Materials

Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
    A. Imprecise method, good for rough estimates only
    B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
    A. High-carbon steels show more spark bursts than do low-carbon steels.
    B. Non-ferrous metals
        1. Aluminum
        2. Magnesium
        3. Brass
        4. Bronze
        5. Nickel
        6. Tin
        7. Others
III. Perform Rockwell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
    A. Ferrous metals
    B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L6-HO4
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

c. Verbally warn others of intent to arc weld
d. Strike an arc
e. Weld with stringer bead technique
f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    a. Make manual free hand straight line cuts
    b. Cut manually straight lines using cutting jib
    c. Bevel plate with manual oxy-fuel equipment
    d. Manually cut blind holes in thick material
    e. Manually cut sheet metal with minimal distortion

WLD-L6-HO5
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

   - g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   - h. Chip slag and wire brush weld
   - i. Grind any lack of fusion and/or high spots
   - j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   - k. Visually inspect weld on the root and face sides to ASME Section 9
   - l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   - a. Measure the pipe
   - b. Mark the cut line with a wrap around and soapstone
   - c. Cut the bevel using oxy-fuel gas equipment
   - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Tack the single V groove pipe joint with a 3/32" root opening
   - g. Weld pipe joint
   - h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   - i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   - j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   - k. Visually inspect weld on the root and face sides to ASME Section 9
   - l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Roll Weld Pipe - SMAW
   - a. Measure the pipe
   - b. Mark the cut line with a wrap around and soapstone
   - c. Cut the bevel using oxy-fuel gas equipment
   - d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   - e. Use the grinder to add a root face of from 3/32" to 1/8"
   - f. Tack the single V groove pipe joint with a 3/32" root opening
   - g. Roll weld pipe
   - h. Place pipe coupon on workbench in the 1G roll welding position.
   - i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   - j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L6-HO6
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    a. Produce end preparations with oxy-fuel cutting
    b. Produce end preparations with plasma cutting
    c. Produce end preparations with mechanical cutting
    d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    a. Cut and single bevel pipe to 37 1/2°
    b. Ground bevel face and touch up to within tolerances
    c. Check that pipe ends are square within given tolerances
    d. Prepare root face within given tolerances
    e. Align pipe to within given tolerances
    f. Set root opening to within given tolerances
    g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    b. Weld remainder of pipe in the 1G roll welding position with E6010
    c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    a. Weld using 1/8" E6010
    b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    d. Weld root pass to ASME Section 9 requirements
    e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    a. Fit and tack weld pipe to within tolerances
    b. Place pipe in the 5G position
    c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
    d. Grind the finished root pass to remove high spots and any slag at weld toes

    e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
    a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
    b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
    c. Weld remainder of pipe in 1G position using E7018
    d. Perform low hydrogen starts and stops
    e. Weld using stringer bead technique
    f. Weld using weave technique
    g. Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
    a. Use 1/8" E6010
    b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
    c. Fit together two pipe ends to a single V edge preparation within given tolerances
    c. Weld root pass to ASME Section 9 requirements
    d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
    e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
    a. Set up GMAW equipment
    b. Adjust wire feeder drive system
    c. Adjust shielding gas system and flow rate
    d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
    e. Set welding condition for short circuit transfer - Wire Feed Speed
    f. Set welding condition for short circuit transfer - Voltage
    g. Set welding condition for short circuit transfer - Tip to work Distance
    h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
    a. Bevel pipe ends
    b. Touch up bevel face with grinder
    c. Fit and tack backing ring to one pipe end
    d. Fit other pipe over backing ring
    e. Adjust gap and tack in place
    f. Adjust shielding gas flow
    g. Adjust wire feed system
    h. Adjust power source to procedure specification
    i. Set wire feed speed to procedure specification
    j. Adjust voltage to procedure specification
    k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: **Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.**

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L6-LW
Use the Carbon Arc Process to Cut and Gouge Base Weld Materials
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current

DC+(DCRP) Direct Current Reverse Polarity

DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

        - (1) Product design
        - (2) Material thickness
        - (3) Design strength requirements
        - (4) Welding process employed
    - b. SMAW weld joint configuration may be a:
        - (1) Lap joint
        - (2) Tee joint
        - (3) Corner joint
        - (4) Edge joint
        - (5) Butt joint with backing
        - (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
- a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
- b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
- a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
- b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
- c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.
b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

WLD-L7-HO1
Apply Welders Identification
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Discuss welder identification systems;
B. Use tools, etc., to apply welder identification; and,
C. Use temperature sticks to indicate temperatures.

MODULE OUTLINE:

Instructor Topics:

A. Welder's Identification applied using AWS guidelines and welding procedure specification
B. Welders Tools used for marking
C. Marking and Identification of materials by Welding Inspectors
D. Methods to Indicate Temperatures

Student Activities:

Students will observe examples of company procedures for marking:

A. Any required individual identification marked will be adjacent to each weld
B. Companies provide instructions in welding operations manual or manufacturing instructions and procedures
C. Markings are usually made with low stress steel die stamps
D. Requirements for detailed records are included in welding procedure specification
E. Students will practice with temperature "sticks" or indicators that melt or change color

WLD-L7-HO2
Apply Welders Identification
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
    A. Hardening for utility
    B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
    A. Brine (water and sodium chloride or sodium hydroxide)
    B. Water
    C. Fused (liquid) salts
    D. Molten lead
    E. Soluble oil and water
    F. Oil
    G. Air
IV. Estimate Metal Heat Temperature by Color
    A. Use of temper color chart for tempering
    B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
    A. Increased machinability
    B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
    A. Protective Gear against . . .
        1. Heat
        2. Fumes
        3. Concussion
    B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
    A. Brittleness
    B. Distortion
    C. Discoloration (sometimes unimportant)
    D. Inadvertent heat treating

WLD-L7-HO3
Apply Welders Identification
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
   A. Imprecise method, good for rough estimates only
   B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
   A. High-carbon steels show more spark bursts than do low-carbon steels.
   B. Non-ferrous metals
      1. Aluminum
      2. Magnesium
      3. Brass
      4. Bronze
      5. Nickel
      6. Tin
      7. Others
III. Perform Rockwell Hardness Tests
   A. Ferrous metals
   B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
   A. Ferrous metals
   B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
   A. Ferrous metals
   B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L7-HO4
Apply Welders Identification
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

   - c. Verbally warn others of intent to arc weld
   - d. Strike an arc
   - e. Weld with stringer bead technique
   - f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
   - a. Maintain required weld quality
   - b. Maintain proper weld width uniformly
   - c. Maintain proper travel speed
   - d. Match correct oscillation for various electrodes
   - e. Match applications to weave techniques, as they apply
   - f. List the advantages and disadvantages of weave techniques
   - g. List the advantages and disadvantages of stringer techniques
   - h. Perform weld using weave technique
   - i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   - a. Weld a dam to outline area being welded for each layer
   - b. Apply each layer neatly, straight and with good fusion throughout
   - c. Chip slag after each pass
   - d. Weld passes which over lap to crown of last weld bead
   - e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   - a. Follow manufacturer's recommended practice
   - b. Inspect equipment and work area for safety
   - c. Assemble oxy-fuel equipment
   - d. Open fuel gas cylinder ½ turn
   - e. Open oxygen as cylinder all the way
   - f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   - g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
   - a. Make manual free hand straight line cuts
   - b. Cut manually straight lines using cutting jib
   - c. Bevel plate with manual oxy-fuel equipment
   - d. Manually cut blind holes in thick material
   - e. Manually cut sheet metal with minimal distortion

WLD-L7-HO5
Apply Welders Identification
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
   a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
   b. Use grinder to remove oxide larger and smooth plate
   c. Use grinder to create root face of 3/32" to 1/8"
   d. Tack single V groove joint with 3/32" root opening
   e. Place joint in the 1G position
   f. Place joint in 2G position once task is mastered
   g. Place joint in 3G position once task is mastered
   h. Place joint in 4G position once task is mastered
   i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
   j. Weld chipped side slag and the root bead is wire brushed
   k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
   l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
   a. Inspect area for safety
   b. Place plate flat on welding table
   c. Place 3" pipe vertically on top of plate and tacked in place
   d. Leave weld coupon in the 2F fixed position
   e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
   f. Visually inspect weld to AWS D1.1
   g. Fill pipe with water for 24 hours
   h. Check for leak
3. Produce SMAW Pipe - 5G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening

   g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   h. Chip slag and wire brush weld
   i. Grind any lack of fusion and/or high spots
   j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Weld pipe joint
   h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Roll Weld Pipe - SMAW
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Roll weld pipe
   h. Place pipe coupon on workbench in the 1G roll welding position.
   i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
l. Visually inspect weld on the root and face sides to ASME Section 9
m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME,Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L7-HO6
Apply Welders Identification
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    a. Produce end preparations with oxy-fuel cutting
    b. Produce end preparations with plasma cutting
    c. Produce end preparations with mechanical cutting
    d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    a. Cut and single bevel pipe to 37 1/2°
    b. Ground bevel face and touch up to within tolerances
    c. Check that pipe ends are square within given tolerances
    d. Prepare root face within given tolerances
    e. Align pipe to within given tolerances
    f. Set root opening to within given tolerances
    g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    b. Weld remainder of pipe in the 1G roll welding position with E6010
    c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    a. Weld using 1/8" E6010
    b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    d. Weld root pass to ASME Section 9 requirements
    e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    a. Fit and tack weld pipe to within tolerances
    b. Place pipe in the 5G position
    c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
    d. Grind the finished root pass to remove high spots and any slag at weld toes

    - e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
    - a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
    - b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
    - c. Weld remainder of pipe in 1G position using E7018
    - d. Perform low hydrogen starts and stops
    - e. Weld using stringer bead technique
    - f. Weld using weave technique
    - g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
    - a. Use 1/8" E6010
    - b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
    - c. Fit together two pipe ends to a single V edge preparation within given tolerances
    - c. Weld root pass to ASME Section 9 requirements
    - d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
    - e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
    - a. Set up GMAW equipment
    - b. Adjust wire feeder drive system
    - c. Adjust shielding gas system and flow rate
    - d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
    - e. Set welding condition for short circuit transfer - Wire Feed Speed
    - f. Set welding condition for short circuit transfer - Voltage
    - g. Set welding condition for short circuit transfer - Tip to work Distance
    - h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
    - a. Bevel pipe ends
    - b. Touch up bevel face with grinder
    - c. Fit and tack backing ring to one pipe end
    - d. Fit other pipe over backing ring
    - e. Adjust gap and tack in place
    - f. Adjust shielding gas flow
    - g. Adjust wire feed system
    - h. Adjust power source to procedure specification
    - i. Set wire feed speed to procedure specification
    - j. Adjust voltage to procedure specification
    - k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L7-LA
Apply Welders Identification
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.

B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.

C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.

D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.

B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.

C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.

D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.

E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.

F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.

G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.

H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L7-LW
Apply Welders Identification
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current

DC+(DCRP) Direct Current Reverse Polarity

DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

        (1) Product design
        (2) Material thickness
        (3) Design strength requirements
        (4) Welding process employed
    b. SMAW weld joint configuration may be a:
        (1) Lap joint
        (2) Tee joint
        (3) Corner joint
        (4) Edge joint
        (5) Butt joint with backing
        (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
    a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
    b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
    a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
    b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
    c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

- a. Type of electrode
- b. Diameter of electrode
- c. Type of current (AC or DC)
- d. Current polarity (DC+ or DC-)
- e. Current setting
- f. Arc length
- g. Travel speed
- h. Electrode angle
- i. Electromagnetic arc blow
- j. Electrode manipulation technique (drag, whip)
- k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

- a. Type of base metal
- b. Thickness of base metal
- c. Surface condition of base metal (clean, rusty, or painted)
- d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

WLD-L8-HO1

Control Post-Weld Temperature According to Procedures

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- A. Identify welding procedure specification;
- B. Use welding current or flame to control temperature; and,
- C. Use temperature stick or other indicators to indicate temperatures.

MODULE OUTLINE:

Instructor Topics:

- A. Welding Procedure Specifications
- B. Preheat and interpass temperatures may be specified as:
  - 1. Minimum temperatures only (mild carbon steel with no special requirements)
  - 2. Maximum temperature only (aluminum and nickel alloys)
  - 3. Minimum and maximum temperatures (low alloy steels with impact requirements)
- C. Tempering and Stress relieving in post weld heat treatment
- D. Heating area and Holding time
- E. Cooling rates
- F. Applicable Codes and Specifications
- G. Heat sources and temperature indication tools must not adversely affect weldment

Student Activities:

- A. Heating and cooling materials, following welding procedure specifications
- B. Use of heat sources and temperature indicators
- C. Making adjustments to improve weld quality
- D. Observation of the use of welding procedures during field trip

WLD-L8-HO2
Control Post-Weld Temperature According to Procedures
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
  A. Hardening for utility
  B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  A. Brine (water and sodium chloride or sodium hydroxide)
  B. Water
  C. Fused (liquid) salts
  D. Molten lead
  E. Soluble oil and water
  F. Oil
  G. Air
IV. Estimate Metal Heat Temperature by Color
  A. Use of temper color chart for tempering
  B. *Chicken Wire* markings warn of overheating

Temperature (F)	**Temperature (C)**	**Oxide Color**	**Suggested Uses**
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L8-HO3

Control Post-Weld Temperature According to Procedures

Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
    A. Imprecise method, good for rough estimates only
    B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
    A. High-carbon steels show more spark bursts than do low-carbon steels.
    B. Non-ferrous metals
        1. Aluminum
        2. Magnesium
        3. Brass
        4. Bronze
        5. Nickel
        6. Tin
        7. Others
III. Perform Rockwell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
    A. Ferrous metals
    B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly
    b. Operate welding helmet

   c. Verbally warn others of intent to arc weld
   d. Strike an arc
   e. Weld with stringer bead technique
   f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool

8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height

9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length

10. Cut Steel Plate Using Oxy-Fuel Equipment
   a. Make manual free hand straight line cuts
   b. Cut manually straight lines using cutting jib
   c. Bevel plate with manual oxy-fuel equipment
   d. Manually cut blind holes in thick material
   e. Manually cut sheet metal with minimal distortion

WLD-L8-HO5
Control Post-Weld Temperature According to Procedures
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

    g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    h. Chip slag and wire brush weld
    i. Grind any lack of fusion and/or high spots
    j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Weld pipe joint
    h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Roll Weld Pipe - SMAW
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Roll weld pipe
    h. Place pipe coupon on workbench in the 1G roll welding position.
    i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

    k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    l. Visually inspect weld on the root and face sides to ASME Section 9
    m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
    a. Measure the pipe and
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Weld pipe
    g. Tack the single V groove pipe joint with a 3/32" root opening
    h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
    i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    l. Visually inspect weld on the root and face sides to ASME Section 9
    m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
    h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L8-HO6

Control Post-Weld Temperature According to Procedures

Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
   a. Produce end preparations with oxy-fuel cutting
   b. Produce end preparations with plasma cutting
   c. Produce end preparations with mechanical cutting
   d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
   a. Cut and single bevel pipe to 37 1/2°
   b. Ground bevel face and touch up to within tolerances
   c. Check that pipe ends are square within given tolerances
   d. Prepare root face within given tolerances
   e. Align pipe to within given tolerances
   f. Set root opening to within given tolerances
   g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
   a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   b. Weld remainder of pipe in the 1G roll welding position with E6010
   c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   a. Weld using 1/8" E6010
   b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   d. Weld root pass to ASME Section 9 requirements
   e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
   a. Fit and tack weld pipe to within tolerances
   b. Place pipe in the 5G position
   c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
   d. Grind the finished root pass to remove high spots and any slag at weld toes

   e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   c. Weld remainder of pipe in 1G position using E7018
   d. Perform low hydrogen starts and stops
   e. Weld using stringer bead technique
   f. Weld using weave technique
   g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   a. Use 1/8" E6010
   b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   c. Fit together two pipe ends to a single V edge preparation within given tolerances
   c. Weld root pass to ASME Section 9 requirements
   d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
   a. Set up GMAW equipment
   b. Adjust wire feeder drive system
   c. Adjust shielding gas system and flow rate
   d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   e. Set welding condition for short circuit transfer - Wire Feed Speed
   f. Set welding condition for short circuit transfer - Voltage
   g. Set welding condition for short circuit transfer - Tip to work Distance
   h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
   a. Bevel pipe ends
   b. Touch up bevel face with grinder
   c. Fit and tack backing ring to one pipe end
   d. Fit other pipe over backing ring
   e. Adjust gap and tack in place
   f. Adjust shielding gas flow
   g. Adjust wire feed system
   h. Adjust power source to procedure specification
   i. Set wire feed speed to procedure specification
   j. Adjust voltage to procedure specification
   k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L8-LA
Control Post-Weld Temperature According to Procedures
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L8-LW

Control Post-Weld Temperature According to Procedures

Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**

   Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

   Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

   Step 1. Choose the proper electrode for the job.

   NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

   The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

   Step 2. Store the electrodes properly.

   a. Low-hydrogen electrodes:

   (1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

   (2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

   (3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

   NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:
AC Alternating Current
DC+(DCRP) Direct Current Reverse Polarity
DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

(1) Product design
(2) Material thickness
(3) Design strength requirements
(4) Welding process employed

b. SMAW weld joint configuration may be a:
(1) Lap joint
(2) Tee joint
(3) Corner joint
(4) Edge joint
(5) Butt joint with backing
(6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. Troubleshoot Welding Problems

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

- a. Type of electrode
- b. Diameter of electrode
- c. Type of current (AC or DC)
- d. Current polarity (DC+ or DC-)
- e. Current setting
- f. Arc length
- g. Travel speed
- h. Electrode angle
- i. Electromagnetic arc blow
- j. Electrode manipulation technique (drag, whip)
- k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

- a. Type of base metal
- b. Thickness of base metal
- c. Surface condition of base metal (clean, rusty, or painted)
- d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

WLD-L9-HO1

Post Clean Weld

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify material not associated with weld metal;

B. Use a variety of tools to remove residue material; and,

C. Identify when all slag, etc., is removed.

MODULE OUTLINE:

Instructor Topics:

A. Joint preparation and cleaning of surfaces for welding

B. Post cleaning of weld following welding procedure specifications

C. Examples of cleaning processes followed by major manufacturers

D. Demonstrate knowledge of the proper application of welding skills

Student Activities:

A. Joint preparations and metal cleaning of surfaces for welding

B. Oxygen cutting, air carbon arc, or plasma cutting (may involve marking or grinding followed by cleaning

C. Post cleaning of weld (with examples from major industries of specific products and cleaning methods

D. Oxide layers may be removed by grinding, sanding, or stainless brushing

WLD-L9-HO2
Post Clean Weld
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- a. Discuss the reasons for heat treating;
- b. Discuss the time/temperature chart
- c. List the different quenching media
- d. Estimate metal heat temperature by color; and
- e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

- I. Discuss the Reasons for Heat Treating
  - A. Hardening for utility
  - B. Tempering for toughness without brittleness
- II. Discuss the Time/Temperature Chart
- III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  - A. Brine (water and sodium chloride or sodium hydroxide)
  - B. Water
  - C. Fused (liquid) salts
  - D. Molten lead
  - E. Soluble oil and water
  - F. Oil
  - G. Air
- IV. Estimate Metal Heat Temperature by Color
  - A. Use of temper color chart for tempering
  - B. *Chicken Wire* markings warn of overheating

Temperature (F)	**Temperature (C)**	**Oxide Color**	**Suggested Uses**
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L9-HO3
Post Clean Weld
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
  A. Imprecise method, good for rough estimates only
  B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
  A. High-carbon steels show more spark bursts than do low-carbon steels.
  B. Non-ferrous metals
    1. Aluminum
    2. Magnesium
    3. Brass
    4. Bronze
    5. Nickel
    6. Tin
    7. Others
III. Perform Rockwell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
  A. Ferrous metals
  B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
  A. Ferrous metals
  B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L9-HO4
Post Clean Weld
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
   a. Define arc welding process terms
   b. Define standard joint terminology
   c. Define common weld discontinuities
   d. Name welding equipment, supply and consumables
   e. Define common shop terms including proper equipment names
   f. Define material terms
   g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
   a. List, describe and define
   b. List low hydrogen electrodes
   c. List iron powder electrodes
   d. Describe electrode by welding position
   e. Describe electrode by current and polarity
   f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
   a. List polarities for commonly used electrodes
   b. Describe both polarities
   c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
   a. Describe and demonstrate start for non-low hydrogen SMAW electrode
   b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
   c. List reasons for the importance of low hydrogen in weld metal
   d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
   a. Inspect area for safety
   b. Adjust current and polarity for specific job requirements
   c. Choose type and size of electrode
   d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
   a. Stand and position oneself correctly
   b. Operate welding helmet

    c. Verbally warn others of intent to arc weld
    d. Strike an arc
    e. Weld with stringer bead technique
    f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
    a. Maintain required weld quality
    b. Maintain proper weld width uniformly
    c. Maintain proper travel speed
    d. Match correct oscillation for various electrodes
    e. Match applications to weave techniques, as they apply
    f. List the advantages and disadvantages of weave techniques
    g. List the advantages and disadvantages of stringer techniques
    h. Perform weld using weave technique
    i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
    a. Weld a dam to outline area being welded for each layer
    b. Apply each layer neatly, straight and with good fusion throughout
    c. Chip slag after each pass
    d. Weld passes which over lap to crown of last weld bead
    e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
    a. Follow manufacturer's recommended practice
    b. Inspect equipment and work area for safety
    c. Assemble oxy-fuel equipment
    d. Open fuel gas cylinder ½ turn
    e. Open oxygen as cylinder all the way
    f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
    g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    a. Make manual free hand straight line cuts
    b. Cut manually straight lines using cutting jib
    c. Bevel plate with manual oxy-fuel equipment
    d. Manually cut blind holes in thick material
    e. Manually cut sheet metal with minimal distortion

WLD-L9-HO5
Post Clean Weld
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

   g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   h. Chip slag and wire brush weld
   i. Grind any lack of fusion and/or high spots
   j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Weld pipe joint
   h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9
   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Roll weld pipe
   h. Place pipe coupon on workbench in the 1G roll welding position.
   i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L9-HO6

Post Clean Weld

Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
   a. Produce end preparations with oxy-fuel cutting
   b. Produce end preparations with plasma cutting
   c. Produce end preparations with mechanical cutting
   d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
   a. Cut and single bevel pipe to 37 1/2°
   b. Ground bevel face and touch up to within tolerances
   c. Check that pipe ends are square within given tolerances
   d. Prepare root face within given tolerances
   e. Align pipe to within given tolerances
   f. Set root opening to within given tolerances
   g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
   a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   b. Weld remainder of pipe in the 1G roll welding position with E6010
   c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   a. Weld using 1/8" E6010
   b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   d. Weld root pass to ASME Section 9 requirements
   e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
   a. Fit and tack weld pipe to within tolerances
   b. Place pipe in the 5G position
   c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
   d. Grind the finished root pass to remove high spots and any slag at weld toes

    e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
    a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
    b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
    c. Weld remainder of pipe in 1G position using E7018
    d. Perform low hydrogen starts and stops
    e. Weld using stringer bead technique
    f. Weld using weave technique
    g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
    a. Use 1/8" E6010
    b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
    c. Fit together two pipe ends to a single V edge preparation within given tolerances
    c. Weld root pass to ASME Section 9 requirements
    d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
    e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
    a. Set up GMAW equipment
    b. Adjust wire feeder drive system
    c. Adjust shielding gas system and flow rate
    d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
    e. Set welding condition for short circuit transfer - Wire Feed Speed
    f. Set welding condition for short circuit transfer - Voltage
    g. Set welding condition for short circuit transfer - Tip to work Distance
    h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
    a. Bevel pipe ends
    b. Touch up bevel face with grinder
    c. Fit and tack backing ring to one pipe end
    d. Fit other pipe over backing ring
    e. Adjust gap and tack in place
    f. Adjust shielding gas flow
    g. Adjust wire feed system
    h. Adjust power source to procedure specification
    i. Set wire feed speed to procedure specification
    j. Adjust voltage to procedure specification
    k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L9-LA
Post Clean Weld
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	Minimum Shade No.	Suggested Shade*
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: **Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.**

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current
DC+(DCRP) Direct Current Reverse Polarity
DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

        (1) Product design
        (2) Material thickness
        (3) Design strength requirements
        (4) Welding process employed
    b. SMAW weld joint configuration may be a:
        (1) Lap joint
        (2) Tee joint
        (3) Corner joint
        (4) Edge joint
        (5) Butt joint with backing
        (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
    a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
    b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. **Complete Welding Operation**

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
    a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
    b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
    c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

    a. As the material thickness increases, the travel speed must slow down.
    b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
    c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

    a. Type of electrode
    b. Diameter of electrode
    c. Type of current (AC or DC)
    d. Current polarity (DC+ or DC-)
    e. Current setting
    f. Arc length
    g. Travel speed
    h. Electrode angle
    i. Electromagnetic arc blow
    j. Electrode manipulation technique (drag, whip)
    k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

    a. Type of base metal
    b. Thickness of base metal
    c. Surface condition of base metal (clean, rusty, or painted)
    d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

WLD-L10-HO1
Post Finish Weld
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify requirements of the welding procedure specification.
B. Use wire brushes, etc., to meet the requirements of the welding procedure specification.

MODULE OUTLINE:

Instructor Topics:

A. "Post finishing" is defined as the process steps to be followed after welding.
B. These steps may be further testing, cleaning, polishing or metal preparation (hardening, etc.) prior to painting or galvanizing the finished product.
C. Many metal products are purchased by customers who require not only a perfect welding product, a high quality finish or appearance that is important to the end user.
D. Applications of chemical cleaning, sanding, and metal preparation for finishing.
E. Importance of the weld to strength function, fit and finish.

Student Activities:

A. Tour a production facility and observe manufacturing processes beginning with materials selection, preparation, welding, weld inspection, and ending with the finishing of the metal product.
B. Assessing the importance of the weld quality to strength, function, fit, and finish.

WLD-L10-HO2
Post Finish Weld
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- a. Discuss the reasons for heat treating;
- b. Discuss the time/temperature chart
- c. List the different quenching media
- d. Estimate metal heat temperature by color; and
- e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

- I. Discuss the Reasons for Heat Treating
  - A. Hardening for utility
  - B. Tempering for toughness without brittleness
- II. Discuss the Time/Temperature Chart
- III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  - A. Brine (water and sodium chloride or sodium hydroxide)
  - B. Water
  - C. Fused (liquid) salts
  - D. Molten lead
  - E. Soluble oil and water
  - F. Oil
  - G. Air
- IV. Estimate Metal Heat Temperature by Color
  - A. Use of temper color chart for tempering
  - B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

- V. List Reasons for Stress Relieving Workpieces
  - A. Increased machinability
  - B. Increased workability in cold processes
- VI. Special Safety Concerns of Heat Treating
  - A. Protective Gear against . . .
    - 1. Heat
    - 2. Fumes
    - 3. Concussion
  - B. Toxicity of Certain Media
- VII. Special Problems in Heat Treating
  - A. Brittleness
  - B. Distortion
  - C. Discoloration (sometimes unimportant)
  - D. Inadvertent heat treating

WLD-L10-HO3
Post Finish Weld
Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- a. Perform file test to test for metal hardness;
- b. Use other tests to identify metals; and,
- c. Perform Rockwell hardness tests.

MODULE OUTLINE:

- I. Perform File Test to Test for Metal Hardness
  - A. Imprecise method, good for rough estimates only
  - B. Requires more experienced machinist
- II. Use Other Tests to Identify Metals
  - A. High-carbon steels show more spark bursts than do low-carbon steels.
  - B. Non-ferrous metals
    - 1. Aluminum
    - 2. Magnesium
    - 3. Brass
    - 4. Bronze
    - 5. Nickel
    - 6. Tin
    - 7. Others
- III. Perform Rockwell Hardness Tests
  - A. Ferrous metals
  - B. Non-ferrous metals
- IV. Perform Brinell Hardness Tests
  - A. Ferrous metals
  - B. Non-ferrous metals
- V. Other Hardness Tests as Specified by the Instructor
  - A. Ferrous metals
  - B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L10-HO4
Post Finish Weld
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    - a. Define arc welding process terms
    - b. Define standard joint terminology
    - c. Define common weld discontinuities
    - d. Name welding equipment, supply and consumables
    - e. Define common shop terms including proper equipment names
    - f. Define material terms
    - g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    - a. List, describe and define
    - b. List low hydrogen electrodes
    - c. List iron powder electrodes
    - d. Describe electrode by welding position
    - e. Describe electrode by current and polarity
    - f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    - a. List polarities for commonly used electrodes
    - b. Describe both polarities
    - c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    - a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    - b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    - c. List reasons for the importance of low hydrogen in weld metal
    - d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    - a. Inspect area for safety
    - b. Adjust current and polarity for specific job requirements
    - c. Choose type and size of electrode
    - d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    - a. Stand and position oneself correctly
    - b. Operate welding helmet

c. Verbally warn others of intent to arc weld
d. Strike an arc
e. Weld with stringer bead technique
f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
   a. Maintain required weld quality
   b. Maintain proper weld width uniformly
   c. Maintain proper travel speed
   d. Match correct oscillation for various electrodes
   e. Match applications to weave techniques, as they apply
   f. List the advantages and disadvantages of weave techniques
   g. List the advantages and disadvantages of stringer techniques
   h. Perform weld using weave technique
   i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   a. Weld a dam to outline area being welded for each layer
   b. Apply each layer neatly, straight and with good fusion throughout
   c. Chip slag after each pass
   d. Weld passes which over lap to crown of last weld bead
   e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   a. Follow manufacturer's recommended practice
   b. Inspect equipment and work area for safety
   c. Assemble oxy-fuel equipment
   d. Open fuel gas cylinder ½ turn
   e. Open oxygen as cylinder all the way
   f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
   a. Make manual free hand straight line cuts
   b. Cut manually straight lines using cutting jib
   c. Bevel plate with manual oxy-fuel equipment
   d. Manually cut blind holes in thick material
   e. Manually cut sheet metal with minimal distortion

WLD-L10-HO5
Post Finish Weld
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

    g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    h. Chip slag and wire brush weld
    i. Grind any lack of fusion and/or high spots
    j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Weld pipe joint
    h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Roll weld pipe
    h. Place pipe coupon on workbench in the 1G roll welding position.
    i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9

   l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
   a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
   b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
   c. Set welding condition to weld open roots
   d. Tack pipe nipples together to form a V groove with a 1/8" root opening
   e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
   f. Weld balance of the V groove with this procedure
   g. Visual inspection is made and evaluated by ASME Section 9
   h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
   a. Identify process
   b. Name joint design
   c. List base material
   d. Give dimensions for root treatment
   e. Name electrode size and type being used
   f. List filler material (if required), classification and specification
   g. Identify shielding gas - type and mixture
   h. List pre and post heat and interpass temperature
   i. Describe initial and interpass cleaning
   j. Describe technique which is used
   k. Produce single or multiple pass weld
   l. Choose current type
   m. Set current amperage
   n. Set current polarity
   o. Set voltage

WLD-L10-HO6
Post Finish Weld
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
   a. Produce end preparations with oxy-fuel cutting
   b. Produce end preparations with plasma cutting
   c. Produce end preparations with mechanical cutting
   d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
   a. Cut and single bevel pipe to 37 1/2°
   b. Ground bevel face and touch up to within tolerances
   c. Check that pipe ends are square within given tolerances
   d. Prepare root face within given tolerances
   e. Align pipe to within given tolerances
   f. Set root opening to within given tolerances
   g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
   a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
   b. Weld remainder of pipe in the 1G roll welding position with E6010
   c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
   a. Weld using 1/8" E6010
   b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
   c. Fit together the two pipe ends to a single V edge preparation with given tolerances
   d. Weld root pass to ASME Section 9 requirements
   e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
   a. Fit and tack weld pipe to within tolerances
   b. Place pipe in the 5G position
   c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements
   d. Grind the finished root pass to remove high spots and any slag at weld toes

   - e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   - a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   - b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   - c. Weld remainder of pipe in 1G position using E7018
   - d. Perform low hydrogen starts and stops
   - e. Weld using stringer bead technique
   - f. Weld using weave technique
   - g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   - a. Use 1/8" E6010
   - b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   - c. Fit together two pipe ends to a single V edge preparation within given tolerances
   - c. Weld root pass to ASME Section 9 requirements
   - d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   - e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
   - a. Set up GMAW equipment
   - b. Adjust wire feeder drive system
   - c. Adjust shielding gas system and flow rate
   - d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   - e. Set welding condition for short circuit transfer - Wire Feed Speed
   - f. Set welding condition for short circuit transfer - Voltage
   - g. Set welding condition for short circuit transfer - Tip to work Distance
   - h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
   - a. Bevel pipe ends
   - b. Touch up bevel face with grinder
   - c. Fit and tack backing ring to one pipe end
   - d. Fit other pipe over backing ring
   - e. Adjust gap and tack in place
   - f. Adjust shielding gas flow
   - g. Adjust wire feed system
   - h. Adjust power source to procedure specification
   - i. Set wire feed speed to procedure specification
   - j. Adjust voltage to procedure specification
   - k. Adjust inductance to procedure specification

l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.

B. Cover all skin surfaces. Keep shirt sleeves rolled down.

C. Wear cuffless pants to eliminate spatter traps.

D. Wear leather boots. Pant legs should cover boot tops.

E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.

F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.

G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.

H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.

I. Wear a 100% cotton cap to protect the head from sparks or spatter.

J. Wear long gauntlet leather gloves.

K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.

L. Protect nearby workers from exposure to the welding arc by putting up shields.

M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.

B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

Worksheet:

1. **Choose Proper Power Source**
   Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.
   Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**
   Step 1. Choose the proper electrode for the job.

   NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

   The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

   Step 2. Store the electrodes properly.
   a. Low-hydrogen electrodes:
      (1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.
      (2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.
      (3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.
      NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be

kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:
AC Alternating Current
DC+(DCRP) Direct Current Reverse Polarity
DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:

(1) Product design
(2) Material thickness
(3) Design strength requirements
(4) Welding process employed

b. SMAW weld joint configuration may be a:
(1) Lap joint
(2) Tee joint
(3) Corner joint
(4) Edge joint
(5) Butt joint with backing
(6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. **Troubleshoot Welding Problems**

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks →												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW [illegible] and [illegible] T and butt [illegible] on various [illegible] in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDs.PM6
071296

Duty L2

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post-finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

278

2784

WLD-L11-HO1
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Set-up work area and equipment;
B. Set-up work piece; and,
C. Weld test piece according to specifications.

MODULE OUTLINE:

Instructor Topics:

A. Emphasizes the advantages and disadvantages involved with the use of SMAW equipment
B. Present joint design, concepts, and welding terms for pipe welding
C. Interpret drawings and blueprints for pipe welding
D. Demonstrate the proper application of welding skills for pipe welding
E. Demonstrate adequate preparation of welding surfaces
F. Increase student skill level to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Demonstrate SMAW in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using SMAW on various metals
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match SMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in multiple positions
C. Use welding technique suitable for pipe welding
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-L11-HO2
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
    A. Hardening for utility
    B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
    A. Brine (water and sodium chloride or sodium hydroxide)
    B. Water
    C. Fused (liquid) salts
    D. Molten lead
    E. Soluble oil and water
    F. Oil
    G. Air
IV. Estimate Metal Heat Temperature by Color
    A. Use of temper color chart for tempering
    B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

- V. List Reasons for Stress Relieving Workpieces
  - A. Increased machinability
  - B. Increased workability in cold processes
- VI. Special Safety Concerns of Heat Treating
  - A. Protective Gear against . . .
    - 1. Heat
    - 2. Fumes
    - 3. Concussion
  - B. Toxicity of Certain Media
- VII. Special Problems in Heat Treating
  - A. Brittleness
  - B. Distortion
  - C. Discoloration (sometimes unimportant)
  - D. Inadvertent heat treating

WLD-L11-HO3

Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position

Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
   A. Imprecise method, good for rough estimates only
   B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
   A. High-carbon steels show more spark bursts than do low-carbon steels.
   B. Non-ferrous metals
      1. Aluminum
      2. Magnesium
      3. Brass
      4. Bronze
      5. Nickel
      6. Tin
      7. Others
III. Perform Rockwell Hardness Tests
   A. Ferrous metals
   B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
   A. Ferrous metals
   B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
   A. Ferrous metals
   B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L11-HO4
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    - a. Define arc welding process terms
    - b. Define standard joint terminology
    - c. Define common weld discontinuities
    - d. Name welding equipment, supply and consumables
    - e. Define common shop terms including proper equipment names
    - f. Define material terms
    - g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    - a. List, describe and define
    - b. List low hydrogen electrodes
    - c. List iron powder electrodes
    - d. Describe electrode by welding position
    - e. Describe electrode by current and polarity
    - f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    - a. List polarities for commonly used electrodes
    - b. Describe both polarities
    - c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    - a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    - b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    - c. List reasons for the importance of low hydrogen in weld metal
    - d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    - a. Inspect area for safety
    - b. Adjust current and polarity for specific job requirements
    - c. Choose type and size of electrode
    - d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    - a. Stand and position oneself correctly

    b. Operate welding helmet
    c. Verbally warn others of intent to arc weld
    d. Strike an arc
    e. Weld with stringer bead technique
    f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
    a. Maintain required weld quality
    b. Maintain proper weld width uniformly
    c. Maintain proper travel speed
    d. Match correct oscillation for various electrodes
    e. Match applications to weave techniques, as they apply
    f. List the advantages and disadvantages of weave techniques
    g. List the advantages and disadvantages of stringer techniques
    h. Perform weld using weave technique
    i. Concentrate on dwell times at edges of weld pool

8. Weld Multi-Layer Buildup
    a. Weld a dam to outline area being welded for each layer
    b. Apply each layer neatly, straight and with good fusion throughout
    c. Chip slag after each pass
    d. Weld passes which over lap to crown of last weld bead
    e. Demonstrate control of bead height

9. Set Up and Shut Down Oxy-Fuel Equipment
    a. Follow manufacturer's recommended practice
    b. Inspect equipment and work area for safety
    c. Assemble oxy-fuel equipment
    d. Open fuel gas cylinder ½ turn
    e. Open oxygen as cylinder all the way
    f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
    g. Purge lines one at a time. One second for each 10 feet of hose length

10. Cut Steel Plate Using Oxy-Fuel Equipment
    a. Make manual free hand straight line cuts
    b. Cut manually straight lines using cutting jib
    c. Bevel plate with manual oxy-fuel equipment
    d. Manually cut blind holes in thick material
    e. Manually cut sheet metal with minimal distortion

WLD-L11-HO5
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
    a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
    b. Use grinder to remove oxide larger and smooth plate
    c. Use grinder to create root face of 3/32" to 1/8"
    d. Tack single V groove joint with 3/32" root opening
    e. Place joint in the 1G position
    f. Place joint in 2G position once task is mastered
    g. Place joint in 3G position once task is mastered
    h. Place joint in 4G position once task is mastered
    i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
    j. Weld chipped side slag and the root bead is wire brushed
    k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
    l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
    a. Inspect area for safety
    b. Place plate flat on welding table
    c. Place 3" pipe vertically on top of plate and tacked in place
    d. Leave weld coupon in the 2F fixed position
    e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
    f. Visually inspect weld to AWS D1.1
    g. Fill pipe with water for 24 hours
    h. Check for leak
3. Produce SMAW Pipe - 5G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening

    g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    h. Chip slag and wire brush weld
    i. Grind any lack of fusion and/or high spots
    j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
4. Produce SMAW - 2G Position Groove Welds
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Weld pipe joint
    h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria
5. Roll Weld Pipe - SMAW
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Roll weld pipe
    h. Place pipe coupon on workbench in the 1G roll welding position.
    i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

    k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    l. Visually inspect weld on the root and face sides to ASME Section 9
    m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
    a. Measure the pipe and
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Weld pipe
    g. Tack the single V groove pipe joint with a 3/32" root opening
    h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
    i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
    l. Visually inspect weld on the root and face sides to ASME Section 9
    m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
    h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9

- l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
   - a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
   - b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
   - c. Set welding condition to weld open roots
   - d. Tack pipe nipples together to form a V groove with a 1/8" root opening
   - e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
   - f. Weld balance of the V groove with this procedure
   - g. Visual inspection is made and evaluated by ASME Section 9
   - h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
   - a. Identify process
   - b. Name joint design
   - c. List base material
   - d. Give dimensions for root treatment
   - e. Name electrode size and type being used
   - f. List filler material (if required), classification and specification
   - g. Identify shielding gas - type and mixture
   - h. List pre and post heat and interpass temperature
   - i. Describe initial and interpass cleaning
   - j. Describe technique which is used
   - k. Produce single or multiple pass weld
   - l. Choose current type
   - m. Set current amperage
   - n. Set current polarity
   - o. Set voltage

WLD-L11-HO6
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    a. Produce end preparations with oxy-fuel cutting
    b. Produce end preparations with plasma cutting
    c. Produce end preparations with mechanical cutting
    d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    a. Cut and single bevel pipe to 37 1/2°
    b. Ground bevel face and touch up to within tolerances
    c. Check that pipe ends are square within given tolerances
    d. Prepare root face within given tolerances
    e. Align pipe to within given tolerances
    f. Set root opening to within given tolerances
    g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    b. Weld remainder of pipe in the 1G roll welding position with E6010
    c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    a. Weld using 1/8" E6010
    b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    d. Weld root pass to ASME Section 9 requirements
    e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    a. Fit and tack weld pipe to within tolerances
    b. Place pipe in the 5G position
    c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements

   - d. Grind the finished root pass to remove high spots and any slag at weld toes
   - e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   - a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   - b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   - c. Weld remainder of pipe in 1G position using E7018
   - d. Perform low hydrogen starts and stops
   - e. Weld using stringer bead technique
   - f. Weld using weave technique
   - g Chip slag wire brush and grind as necessary to assure clean weld deposits
7. Weld Open Root Pipe - 2G Position
   - a. Use 1/8" E6010
   - b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   - c. Fit together two pipe ends to a single V edge preparation within given tolerances
   - c. Weld root pass to ASME Section 9 requirements
   - d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   - e. Weld remainder of the groove using E7018 with the stringer bead technique
8. Weld Pipe Open Root Passes All Positions Using GMAW
   - a. Set up GMAW equipment
   - b. Adjust wire feeder drive system
   - c. Adjust shielding gas system and flow rate
   - d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   - e. Set welding condition for short circuit transfer - Wire Feed Speed
   - f. Set welding condition for short circuit transfer - Voltage
   - g. Set welding condition for short circuit transfer - Tip to work Distance
   - h. Weld root using a string bead technique
9. Weld Pipe With Backing Using FCAW-G
   - a. Bevel pipe ends
   - b. Touch up bevel face with grinder
   - c. Fit and tack backing ring to one pipe end
   - d. Fit other pipe over backing ring
   - e. Adjust gap and tack in place
   - f. Adjust shielding gas flow
   - g. Adjust wire feed system
   - h. Adjust power source to procedure specification
   - i. Set wire feed speed to procedure specification

j. Adjust voltage to procedure specification
k. Adjust inductance to procedure specification
l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L11-LA
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: **Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.**

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: **Electrical shock can be avoided by following specific safety precautions.**

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.
C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.
D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.
E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.
F. Do not weld on materials having either a coating or internal structure that is combustible.
G. Place hot scrap and slag in non-combustible containers.
H. Ensure that fire extinguishers are available nearby.
I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.
J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L11-LW
Pass a Performance Qualification Test Using SMAW on Carbon Steel Pipe In the 6G Position
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC Alternating Current

DC+(DCRP) Direct Current Reverse Polarity

DC-(DCSP) Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.
  a. Weld joint configuration will depend upon:
    (1) Product design
    (2) Material thickness
    (3) Design strength requirements
    (4) Welding process employed
  b. SMAW weld joint configuration may be a:
    (1) Lap joint
    (2) Tee joint
    (3) Corner joint
    (4) Edge joint
    (5) Butt joint with backing
    (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up
  a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
  b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
  a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
  b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
  c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely

related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. Troubleshoot Welding Problems

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

WLD-L12-HO1
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Set-up work area and equipment;
B. Set-up work piece; and,
C. Weld test piece according to specifications.

MODULE OUTLINE:

Instructor Topics:

A. Considerations and principles involved in the welding of pipe with SMAW
B. Joint design and welding terms for pipe welding
C. Interpret drawings and blueprints for pipe welding
D. The proper application of welding skills for pipe welding
E. The adequate preparation of welding surfaces for pipe welding
F. Skill levels needed to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Demonstrate preheat and how to maintain desired temperature
I. Identify welding variables and their effects on weld quality
J. Identify the AISI steel classification system
K. Match SMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform pipe welds in multiple positions
C. Use welding techniques appropriate for pipe welding
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-L12-HO2
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 2: **MASTER** Handout No. 2

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Discuss the reasons for heat treating;
b. Discuss the time/temperature chart
c. List the different quenching media
d. Estimate metal heat temperature by color; and
e. List reasons for stress relieving workpieces.

MODULE OUTLINE:

I. Discuss the Reasons for Heat Treating
  A. Hardening for utility
  B. Tempering for toughness without brittleness
II. Discuss the Time/Temperature Chart
III. List the Different Quenching Media (In order of *severity* or speed of quenching)
  A. Brine (water and sodium chloride or sodium hydroxide)
  B. Water
  C. Fused (liquid) salts
  D. Molten lead
  E. Soluble oil and water
  F. Oil
  G. Air
IV. Estimate Metal Heat Temperature by Color
  A. Use of temper color chart for tempering
  B. *Chicken Wire* markings warn of overheating

Temperature (F)	Temperature (C)	Oxide Color	Suggested Uses
425	220	Light Straw	Steel-cutting tools
462	240	Dark Straw	Punches & Dies
490	258	Gold	Shear blades
500	260	Purple	Wood-cutting tools
540	282	Violet	Screwdrivers
580	304	Pale Blue	Springs
620	327	Steel Gray	None

V. List Reasons for Stress Relieving Workpieces
  A. Increased machinability
  B. Increased workability in cold processes
VI. Special Safety Concerns of Heat Treating
  A. Protective Gear against . . .
    1. Heat
    2. Fumes
    3. Concussion
  B. Toxicity of Certain Media
VII. Special Problems in Heat Treating
  A. Brittleness
  B. Distortion
  C. Discoloration (sometimes unimportant)
  D. Inadvertent heat treating

WLD-L12-HO3

Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position

Attachment 3: **MASTER** Handout No. 3

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

a. Perform file test to test for metal hardness;
b. Use other tests to identify metals; and,
c. Perform Rockwell hardness tests.

MODULE OUTLINE:

I. Perform File Test to Test for Metal Hardness
    A. Imprecise method, good for rough estimates only
    B. Requires more experienced machinist
II. Use Other Tests to Identify Metals
    A. High-carbon steels show more spark bursts than do low-carbon steels.
    B. Non-ferrous metals
        1. Aluminum
        2. Magnesium
        3. Brass
        4. Bronze
        5. Nickel
        6. Tin
        7. Others
III. Perform Rockwell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
IV. Perform Brinell Hardness Tests
    A. Ferrous metals
    B. Non-ferrous metals
V. Other Hardness Tests as Specified by the Instructor
    A. Ferrous metals
    B. Non-ferrous metals

ROCKWELL HARDNESS TEST

Sample	Rockwell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

BRINELL HARDNESS TEST

Sample	Brinell Hardness Number	Preliminary Identification
1		
2		
3		
4		
5		

OTHER HARDNESS TEST

Sample	Hardness Designation	Preliminary Identification
1		
2		
3		
4		
5		

WLD-L12-HO4
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe
In the 6G Position
Attachment 4: **MASTER** Handout No. 4

Student laboratory exercises as assigned by Instructor.

BASIC SHIELDED METAL ARC WELDING (SMAW) AND OXY-FUEL GAS CUTTING

1. Define Selected Welding Terms Per AWS A3.0
    a. Define arc welding process terms
    b. Define standard joint terminology
    c. Define common weld discontinuities
    d. Name welding equipment, supply and consumables
    e. Define common shop terms including proper equipment names
    f. Define material terms
    g. Define common metallurgy terms
2. Describe AWS Code for Mild Steel Electrodes
    a. List, describe and define
    b. List low hydrogen electrodes
    c. List iron powder electrodes
    d. Describe electrode by welding position
    e. Describe electrode by current and polarity
    f. Describe electrode by penetration
3. Set Up Welding Machine to Required Polarity
    a. List polarities for commonly used electrodes
    b. Describe both polarities
    c. Describe advantages and disadvantages of alternating current
4. Use Correct Start and Stop Techniques for SMAW Electrodes
    a. Describe and demonstrate start for non-low hydrogen SMAW electrode
    b. Describe and demonstrate stop for non-low hydrogen SMAW electrodes with filled craters
    c. List reasons for the importance of low hydrogen in weld metal
    d. Explain the reason for low hydrogen starts and stops and how they work and why required specifically with E7018
5. Set Up Equipment for Shielded Metal Arc Welding
    a. Inspect area for safety
    b. Adjust current and polarity for specific job requirements
    c. Choose type and size of electrode
    d. Wear applicable personal safety equipment
6. Strike an Arc, Run Continuous Stringer Bead
    a. Stand and position oneself correctly

- b. Operate welding helmet
- c. Verbally warn others of intent to arc weld
- d. Strike an arc
- e. Weld with stringer bead technique
- f. Perform weld tie ins to make continuous bead

7. Weld Using Weave Technique
   - a. Maintain required weld quality
   - b. Maintain proper weld width uniformly
   - c. Maintain proper travel speed
   - d. Match correct oscillation for various electrodes
   - e. Match applications to weave techniques, as they apply
   - f. List the advantages and disadvantages of weave techniques
   - g. List the advantages and disadvantages of stringer techniques
   - h. Perform weld using weave technique
   - i. Concentrate on dwell times at edges of weld pool
8. Weld Multi-Layer Buildup
   - a. Weld a dam to outline area being welded for each layer
   - b. Apply each layer neatly, straight and with good fusion throughout
   - c. Chip slag after each pass
   - d. Weld passes which over lap to crown of last weld bead
   - e. Demonstrate control of bead height
9. Set Up and Shut Down Oxy-Fuel Equipment
   - a. Follow manufacturer's recommended practice
   - b. Inspect equipment and work area for safety
   - c. Assemble oxy-fuel equipment
   - d. Open fuel gas cylinder ½ turn
   - e. Open oxygen as cylinder all the way
   - f. Adjust fuel gas and oxygen working pressure per manufacturer's recommendation
   - g. Purge lines one at a time. One second for each 10 feet of hose length
10. Cut Steel Plate Using Oxy-Fuel Equipment
    - a. Make manual free hand straight line cuts
    - b. Cut manually straight lines using cutting jib
    - c. Bevel plate with manual oxy-fuel equipment
    - d. Manually cut blind holes in thick material
    - e. Manually cut sheet metal with minimal distortion

WLD-L12-HO5
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 5: **MASTER** Handout No. 5

Student laboratory exercises as assigned by Instructor.

ADVANCED SHIELDED METAL ARC WELDING (SMAW) AND CUTTING

1. Weld Single V Groove Welds With Open Roots From One Side
   a. Bevel 3/8" steel plate to 37 1/2° using oxy-fuel gas cutting e.g.
   b. Use grinder to remove oxide larger and smooth plate
   c. Use grinder to create root face of 3/32" to 1/8"
   d. Tack single V groove joint with 3/32" root opening
   e. Place joint in the 1G position
   f. Place joint in 2G position once task is mastered
   g. Place joint in 3G position once task is mastered
   h. Place joint in 4G position once task is mastered
   i. Weld the root with Direct Current Electrode Positive using 1/8" E6010. Use tight arc length and keyhole technique to produce a well fused root bead extending 1/16" above the plate.
   j. Weld chipped side slag and the root bead is wire brushed
   k. Fill the balance of the groove with 3/32", 1/8" and/or 5/32" E7018 using the stringer bead technique
   l. Visual test finished weld and root face bends evaluated to AWS D1.1 criteria
2. Weld Various Diameters of Pipe to Plate
   a. Inspect area for safety
   b. Place plate flat on welding table
   c. Place 3" pipe vertically on top of plate and tacked in place
   d. Leave weld coupon in the 2F fixed position
   e. Apply a 3/8" fillet weld using 1/8" E7018 and a stringer bead technique
   f. Visually inspect weld to AWS D1.1
   g. Fill pipe with water for 24 hours
   h. Check for leak
3. Produce SMAW Pipe - 5G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening

    g. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    h. Chip slag and wire brush weld
    i. Grind any lack of fusion and/or high spots
    j. Weld the balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

4. Produce SMAW - 2G Position Groove Welds
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Weld pipe joint
    h. Place the joint in the 2G fixed position, using an 1/8" E6010 and a keyhole technique. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
    i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
    j. Weld balance of the groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
    k. Visually inspect weld on the root and face sides to ASME Section 9
    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

5. Roll Weld Pipe - SMAW
    a. Measure the pipe
    b. Mark the cut line with a wrap around and soapstone
    c. Cut the bevel using oxy-fuel gas equipment
    d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
    e. Use the grinder to add a root face of from 3/32" to 1/8"
    f. Tack the single V groove pipe joint with a 3/32" root opening
    g. Roll weld pipe
    h. Place pipe coupon on workbench in the 1G roll welding position.
    i. Weld the root bead using 1/8" E6010 and the keyhole technique. The weld is performed in the 2:00 to 12:30 position
    j. Chip slag and wire brush. Grind any lack of fusion and/or high spots

   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

6. Produce SMAW Pipe - 5G Position
   a. Measure the pipe and
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Weld pipe
   g. Tack the single V groove pipe joint with a 3/32" root opening
   h. Place the joint in the 5G fixed position, using an 1/8" E6010 and a keyhole technique
   i. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   j. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   k. Weld balance of groove upward with 3/32" or 1/8" E7018 using the weave technique
   l. Visually inspect weld on the root and face sides to ASME Section 9
   m. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

7. Produce SMAW Pipe - 6G Position
   a. Measure the pipe
   b. Mark the cut line with a wrap around and soapstone
   c. Cut the bevel using oxy-fuel gas equipment
   d. Clean the bevel face with a grinder, remove all oxide and smooth bevel face
   e. Use the grinder to add a root face of from 3/32" to 1/8"
   f. Tack the single V groove pipe joint with a 3/32" root opening
   g. Place the joint in the 6G fixed position, using an 1/8" E6010 and a keyhole technique
   h. Weld the root pass upward producing a root weld which is well fused and has a 1/16" weld reinforcement above the plate
   i. Chip slag and wire brush. Grind any lack of fusion and/or high spots
   j. Weld balance of groove upward with 3/32" or 1/8" E7018 using the stringer bead technique
   k. Visually inspect weld on the root and face sides to ASME Section 9

    l. Remove four guided bend specimens from 2:00, 4:00, 8:00 and 10:00 positions prepared and two & eight are root bend specimens. Four & ten are face bend specimens. Guided bend tests are evaluated to ASME Section 9 criteria

8. Create SMAW Pipe to ASME Section 9
    a. Bevel two pieces of pipe to 30° bevel angle using oxy-fuel gas cutting equipment
    b. Clean bevel face and a 3/32" root face is applied using a hand held grinder
    c. Set welding condition to weld open roots
    d. Tack pipe nipples together to form a V groove with a 1/8" root opening
    e. Place pipe in the 5G fixed position. The root pass is welded and cleaned by wire brushing
    f. Weld balance of the V groove with this procedure
    g. Visual inspection is made and evaluated by ASME Section 9
    h. Make four bend samples and evaluate by ASME Section 9
9. Interpret Welding Procedures
    a. Identify process
    b. Name joint design
    c. List base material
    d. Give dimensions for root treatment
    e. Name electrode size and type being used
    f. List filler material (if required), classification and specification
    g. Identify shielding gas - type and mixture
    h. List pre and post heat and interpass temperature
    i. Describe initial and interpass cleaning
    j. Describe technique which is used
    k. Produce single or multiple pass weld
    l. Choose current type
    m. Set current amperage
    n. Set current polarity
    o. Set voltage

WLD-L12-HO6
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 6: **MASTER** Handout No. 6

Student laboratory exercises as assigned by Instructor.

PIPE WELDING - SMAW

1. Produce End Preparations
    - a. Produce end preparations with oxy-fuel cutting
    - b. Produce end preparations with plasma cutting
    - c. Produce end preparations with mechanical cutting
    - d. Produce end preparations with grinding
2. Fit and Tack Weld Pipe
    - a. Cut and single bevel pipe to 37 1/2°
    - b. Ground bevel face and touch up to within tolerances
    - c. Check that pipe ends are square within given tolerances
    - d. Prepare root face within given tolerances
    - e. Align pipe to within given tolerances
    - f. Set root opening to within given tolerances
    - g. Tack pipe according to welding procedure specification - maintaining root opening
3. Roll Weld Open Root Pass on Pipe - 1G Position
    - a. Fit up and tack pipe joint using 1/8" E6010 electrode, weld the root pass on pipe in the 1 o'clock to (2:00 o'clock position) according to procedure using the roll welding technique
    - b. Weld remainder of pipe in the 1G roll welding position with E6010
    - c. Weld the remaining portion of the groove using the weave technique using 5/32" E6010 electrode roll
4. Weld Open Root Pipe Joint - 2G Position
    - a. Weld using 1/8" E6010
    - b. Cut and grind pipe ends will be to single bevel edge preparations of 37 1/2°
    - c. Fit together the two pipe ends to a single V edge preparation with given tolerances
    - d. Weld root pass to ASME Section 9 requirements
    - e. Fill balance of the groove with E6010 using the stringer technique to ASME Section 9 requirements
5. Weld Open Root Pipe - 5G Position
    - a. Fit and tack weld pipe to within tolerances
    - b. Place pipe in the 5G position
    - c. Weld the rootpass using 1/8" E6010 to ASME Section 9 requirements

  - d. Grind the finished root pass to remove high spots and any slag at weld toes
  - e. Weld the remainder of the groove using 3/32" and/or 1/8" E7018 using the stringer bead technique to ASME Section 9 requirements

6. Pass Guided Bond Tests Per ASME Section 9
   - a. Remove bend samples from pipe at the 10, 2, 8 & 4 o'clock positions
   - b. If the material is 3/8" or thinner 10 o'clock and 8 o'clock receive root bends and 2 o'clock and 4 o'clock receive face bends. If the pipe wall thickness is over 3/8" side bends shall be performed on all samples.
   - c. Weld remainder of pipe in 1G position using E7018
   - d. Perform low hydrogen starts and stops
   - e. Weld using stringer bead technique
   - f. Weld using weave technique
   - g. Chip slag wire brush and grind as necessary to assure clean weld deposits

7. Weld Open Root Pipe - 2G Position
   - a. Use 1/8" E6010
   - b. Cut and ground pipe ends to single bevel edge preparations of 37 1/2°
   - c. Fit together two pipe ends to a single V edge preparation within given tolerances
   - c. Weld root pass to ASME Section 9 requirements
   - d. Clean weld pass by chipping slag, wire brushing and grinding where necessary to assure a clean, well fused weld deposit
   - e. Weld remainder of the groove using E7018 with the stringer bead technique

8. Weld Pipe Open Root Passes All Positions Using GMAW
   - a. Set up GMAW equipment
   - b. Adjust wire feeder drive system
   - c. Adjust shielding gas system and flow rate
   - d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
   - e. Set welding condition for short circuit transfer - Wire Feed Speed
   - f. Set welding condition for short circuit transfer - Voltage
   - g. Set welding condition for short circuit transfer - Tip to work Distance
   - h. Weld root using a string bead technique

9. Weld Pipe With Backing Using FCAW-G
   - a. Bevel pipe ends
   - b. Touch up bevel face with grinder
   - c. Fit and tack backing ring to one pipe end
   - d. Fit other pipe over backing ring
   - e. Adjust gap and tack in place
   - f. Adjust shielding gas flow
   - g. Adjust wire feed system
   - h. Adjust power source to procedure specification
   - i. Set wire feed speed to procedure specification

j. Adjust voltage to procedure specification
k. Adjust inductance to procedure specification
l. Adjust GMAW gun for tip to work distance and shielding gas
m. Weld according to procedure specification

WLD-L12-LA
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 7: **MASTER** Laboratory Aid

The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.
B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.
C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.
D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.
B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.
C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.
D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.
E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.
F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.
G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).

FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

Application	**Minimum Shade No.**	**Suggested Shade***
Less than 60 amps	7	9
60 to 160 amps	8	10
160 to 250 amps	10	12
250 to 500 amps	11	14

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

Figure 2 Filter Recommendations

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.

B. Remove combustibles from the work area by at least 35 feet if possible.

C. Cover combustibles that can not be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.

D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.

E. If combustibles can not be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.

F. Do not weld on materials having either a coating or internal structure that is combustible.

G. Place hot scrap and slag in non-combustible containers.

H. Ensure that fire extinguishers are available nearby.

I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: **NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails.**
DON'T CARRY A BOMB IN YOUR POCKET.

WLD-L12-LW
Pass a Performance Qualification Test Using SMAW on Stainless Steel Pipe In the 6G Position
Attachment 8: **MASTER** Laboratory Worksheet

Worksheet:

1. **Choose Proper Power Source**

Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**

Step 1. Choose the proper electrode for the job.

NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the *fast-freeze* family of electrodes and the E7018 belongs to the *low-hydrogen* family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

Step 2. Store the electrodes properly.

a. Low-hydrogen electrodes:

(1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

(2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

ROD DESIGNATION	DC+	DC-	AC
E6010	YES	NEVER	NEVER
E7015	YES	NO	NO
E7016	YES	NO	YES
E7018	YES	NO	YES
E7048	YES	NO	YES

Figure 5 Welding Rod Polarities

Definitions:

AC	Alternating Current
DC+(DCRP)	Direct Current Reverse Polarity
DC-(DCSP)	Direct Current Straight Polarity

Electrode Diameter (in.)	Current Range (amp)								
	Electrode Type								
	E6010, E6011 DC+	E6012	E6013	E6020	E6027	E7014	E7015, E7016	E7018	E7024, E7028
1/16	—	20-40	20-40	—	—	—	—	—	—
5/64	—	25-60	25-60	—	—	—	—	—	—
3/32	40-80	35-85	45-90	—	—	80-125	65-110	70-100	100-145*
1/8	75-125	80-140	80-130	100-150	125-185	110-160	100-150	115-165	140-190
5/32	110-170	110-190	105-180	130-190	160-240	150-210	140-200	150-220	180-250
3/16	140-215	140-240	150-230	175-250	210-300	200-275	180-255	200-275	230-305
7/32	170-250	200-320	210-300	225-310	250-350	260-340	240-320	260-340	275-365
1/4	210-320	250-400	250-350	275-375	300-420	330-415	300-390	315-400	335-430
5/16	275-425	300-500	320-430	340-450	375-475	390-500	375-475	375-470	400-525*

Figure 6 Typical Current Ranges for Electrodes

3. Prepare Weldment for Welding

- Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.
  - a. Weld joint configuration will depend upon:
    - (1) Product design
    - (2) Material thickness
    - (3) Design strength requirements
    - (4) Welding process employed
  - b. SMAW weld joint configuration may be a:
    - (1) Lap joint
    - (2) Tee joint
    - (3) Corner joint
    - (4) Edge joint
    - (5) Butt joint with backing
    - (6) Butt joint without backing
- Step 2. Clean the areas to be welded prior to fit-up
  - a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
  - b. Remove oils and greases with a safe, suitable solvent
- Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.
- Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.
- Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

- Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.
- Step 2. Use any preheat that may be required by welding codes or company procedures.
- Step 3. Make the required weld to be defect free and pleasing in appearance.
- Step 4. Use proper weld bead placement according to the weld joint design.
  - a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
  - b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
  - c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.
- Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely

related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.

a. As the material thickness increases, the travel speed must slow down.

b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.

c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. Troubleshoot Welding Problems

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:

a. Type of electrode
b. Diameter of electrode
c. Type of current (AC or DC)
d. Current polarity (DC+ or DC-)
e. Current setting
f. Arc length
g. Travel speed
h. Electrode angle
i. Electromagnetic arc blow
j. Electrode manipulation technique (drag, whip)
k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:

a. Type of base metal
b. Thickness of base metal
c. Surface condition of base metal (clean, rusty, or painted)
d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it.

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW [illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDxPMS [illegible]

[illegible]

Duty M1

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		← Tasks →												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-M1-HO1
Identify GMAW Equipment
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Safely identify and inspect gas metal arc welding equipment and accessories, and shielding gas equipment and accessories;

B. Understand ANSI A49.1, ***Safety in Welding, Cutting and Allied Processes, Part II-Specific Processes, 11. Arc Welding and Cutting Equipment Safety***;

C. Perform routine safety inspections of protective equipment and clothing, gas metal arc welding equipment and accessories, shielding gas equipment and accessories, required tools and the work area; and,

D. Understand welding related terms and definitions.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences in equipment from previous classes

B. Illustrate safety and preventive practices

C. GMAW welding variables and adjustments to equipment

D. The most common GMAW welding applications

E. GMAW filler metal classification by AWS standards

F. Shielding gases used with GMAW

G. Power sources used with GMAW

Student Activities:

A. Select and use personal protective equipment for GMAW

B. Set up equipment for GMAW process

C. Understand the operation and purpose of the wire feeder control system

D. Discuss use of shielding gases

E. Understand the power source operation and the output curve characteristics of both constant current and constant potential power sources

---

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

e. Weld the second pass with electrode centered at the bottom toe of the first pass
f. Weld the third pass with electrode centered at the top toe of the second pass
g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30□ bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M2-HO1
Identify the Safety Hazards
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- A. Review ventilation requirements;
- B. Provide demonstrations related to routine safety inspections of protective equipment and clothing;
- C. Provide demonstrations related to ANSI Z49.1; and,
- D. Provide demonstrations related to safe handling of shielding gas equipment and accessories.

MODULE OUTLINE:

Instructional Topics:
- A. Identify the type of equipment to be used, and the differences of equipment
- B. Illustrate safety and preventive practices
- C. Illustrate welding variables and adjustments to equipment

Student Activities:
- A. Use personal protective equipment
- B. Set up procedure for GMAW process and equipment
- C. Perform beginning welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds

WLD-M2-HO2
Identify the Safety Hazards
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M3-HO1
Describe the Preventive and Protective Measures
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective;
B. Provide instruction related to ANSI Z49.1;
C. Reinforce previous instruction on safety; and,
D. Observe trainee following safe practices.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of GMAW equipment as compared to oxyacetylene
B. Illustrate safety and preventive practices
C. Understand ventilation requirements for shielded gases
D. Use proper filter lens in helmet and protective clothing
E. Wear safety glasses, properly ground the welding machine, and secure all cylinders with safety chains or cables
F. Illustrate welding variables and adjustments to equipment

Student Activities:

A. Use preventive measures and wear protective equipment
B. Set up procedure to be followed for GMAW process and equipment
C. Perform beginning welds on T fillets and butt-joints with various metals and filler wire using single and multi-pass welds

---

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld 1/4" fillet welds in 2F position using string bead technique
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   - g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M4-HO1

Identify Welding Variables and Their Effects Upon Weld Quality

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to gas metal arc welding equipment and accessory set up;
B. Provide demonstrations related to shielding gas equipment and accessory set up;
C. Demonstrate gas metal arc welding principles of operation;
D. Identify the shielding gases relevant to the gas metal arc welding process;
E. Understand the gas metal arc welding filler metal identification and selection process;
F. Introduce related terms and definitions;
G. Follow safe practices;
H. Set up gas metal arc welding equipment and accessories;
I. Set up shielding gas equipment and accessories;
J. Develop and administer formative or diagnostic tests relevant to gas metal arc welding principals; and,
K. Demonstrate proficiency in the gas metal arc welding principles of operation, and filler metal identification/selection,

---

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment
D. Describe the most common GMAW weldability problems
E. Illustrate GMAW filler metal classification by AWS standards
F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Perform Welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
C. Discuss welding variables to include:
    1. Filler metal classification
    2. Material thickness
    3. Joint design
    4. Type of base metal
    5. Welding process

6. Amperage
7. Travel speed
8. Shielding gas flow

WLD-M4-HO2
Identify Welding Variables and Their Effects Upon Weld Quality
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M5-HO1
Troubleshoot Equipment
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to gas metal arc welding component identification;
B. Provide demonstrations related to shielding gas equipment and accessory component identification;
C. Provide demonstrations related to minor external repairs on gas metal arc welding equipment and accessories;
D. Provide demonstrations related to minor external repairs on shielding gas equipment and accessories;
E. Understand related terms and definitions; and,
F. Perform repair assignments when required.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Perform Welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
C. Perform welding in multiple positions
D. Describe the most common GMAW weldability problems
E. Illustrate GMAW filler metal classification by AWS standards
F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System
G. Demonstrate ability to repair welds
H. Demonstrate ability to preheat weld area if necessary

WLD-M5-HO2
Troubleshoot Equipment
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld 1/4" fillet welds in 2F position using string bead technique
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   - g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    - e. Weld the second pass with electrode centered at the bottom toe of the first pass
    - f. Weld the third pass with electrode centered at the top toe of the second pass
    - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M6-HO1

Describe AWS Electrode Classification System

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify GMAW Electrodes using AWS Classification System;

B. Identify compatibility of parent metals and electrodes; and,

C. Illustrate compatibility of parent metals and electrodes/wires by proper selection exercises.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used and the differences of equipment

B. Illustrate safety and preventive practices

C. Illustrate welding variables and adjustments to equipment

D. Describe the most common GMAW weldability problems

E. Use GMAW filler metal classification by AWS standards

F. Select GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment

B. Select GMAW electrodes using AWS and Aluminum Association Classification methods

C. Perform welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds

D. Perform welding in multiple positions

E. Demonstrate ability to repair welds

F. Demonstrate ability to preheat weld area if necessary

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

e. Weld the second pass with electrode centered at the bottom toe of the first pass
f. Weld the third pass with electrode centered at the top toe of the second pass
g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M7-HO1

Describe Aluminum Assoc. Metal Classification System for Aluminum Alloys

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Illustrate GMAW Filler Metal classifications by AWS standards; and,

B. Demonstrate knowledge of aluminum alloys by practice.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment

B. Illustrate safety and preventive practices

C. Illustrate welding variables and adjustments to equipment

D. Describe the most common GMAW weldability problems

E. Illustrate GMAW filler metal classification by AWS standards

F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment

B. Select compatibility filler metal or alloys

C. Perform welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds

D. Perform welding in multiple positions

E. Demonstrate ability to repair welds

F. Demonstrate ability to preheat weld area if necessary

WLD-M7-HO2
Describe Aluminum Assoc. Metal Classification System for Aluminum Alloys
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M8-HO1
Describe Most Common Weldability Problems Associated With Aluminum and Copper Alloys
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand filler metal compatibility associated with aluminum and copper; and,

B. Demonstrate knowledge of weldability by selection of materials and practice.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment

B. Illustrate safety and preventive practices

C. Illustrate welding variables and adjustments to equipment

D. Describe the most common GMAW weldability problems with aluminum and copper

E. Illustrate GMAW filler metal classification by AWS standards

F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment

B. Perform Welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds

C. Perform welding in multiple positions

D. Demonstrate ability to repair welds

E. Demonstrate ability to preheat weld area if necessary

WLD-M8-HO2
Describe Most Common Weldability Problems Associated With Aluminum and Copper Alloys
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

6. Weld With GMAW Using Globular Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M9-HO1
Perform GMAW Fillet and Groove Welds on T and Butt Joints On Various Metals in Various Positions
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide demonstrations related to gas metal arc welding equipment operations;
B. Provide instruction related to gas metal arc welding principles of operation;
C. Provide instruction related to common process variables for gas metal arc welding;
D. Provide training exercises related to gas metal arc welding equipment operation;
E. Provide training exercises related to starting and maintaining an arc on plain carbon steel;
F. Provide training exercises related to flat, multiple pass, multi-directional, surfacing welds, on plain carbon steel, using short circuit transfer, .035 or .045 diameter E70S-X electrodes and a CO_2 or 75% argon/25% CO_2 shielding gas;
G. Provide training exercises related to flat, multiple pass, multi-directional, surfacing welds, on plain carbon steel using spray transfer, .035 or .045 diameter E70S-X electrodes and an argon with shielding gas 2%-5% oxygen;
H. Observe trainee following safe arc welding practices;
I. Observe trainee operating gas metal arc welding equipment;
J. Visually inspect trainee's workmanship samples; and,
K. Develop and administer formative or diagnostic tests relevant to gas metal arc welding principles of operation and common process variables.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventative practices
C. Discuss use of shielding gases for best results with specific applications
D. Illustrate welding variables and adjustments to equipment
E. Describe the most common GMAW weldability problems
F. Illustrate GMAW filler metal classification by AWS standards
G. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Select shielding gases

C. Perform welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
D. Perform welding in multiple positions
E. Demonstrate ability to repair welds
F. Demonstrate ability to preheat weld area if necessary

WLD-M9-HO2

Perform GMAW Fillet and Groove Welds on T and Butt Joints On Various Metals in Various Positions

Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

6. Weld With GMAW Using Globular Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M10-HO1
Demonstrate Aluminum GMAW Flat, Horizontal, Vertical and Overhead
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand spray transfer process on GMAW aluminum alloys.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment
D. Describe the most common GMAW weldability problems
E. Illustrate GMAW filler metal classification by AWS standards
F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Set up procedure for GMAW process and equipment
B. Perform selection of shielding gases and filler wire
C. Perform welds on Tee's and butt-joints with various metals and filler wire using single and multi-pass welds
D. Perform welding in multiple positions
E. Demonstrate ability to repair welds
F. Demonstrate ability to preheat weld area if necessary

WLD-M10-HO2
Demonstrate Aluminum GMAW Flat, Horizontal, Vertical and Overhead
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld 1/4" fillet welds in 2F position using string bead technique
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   - g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Tack a T joint using GMAW
   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

e. Weld the second pass with electrode centered at the bottom toe of the first pass
f. Weld the third pass with electrode centered at the top toe of the second pass
g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M11-HO1

Describe GMAW Filler Wires

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand compatibility of filler metal to base metal; and,
B. Understand AWS Electrode Classification System for GMAW.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of electrode and classification markings
B. Illustrate the significance of classification numbers
C. Present mechanical property requirements
D. Present impact property requirements
E. Present chemical composition requirement
F. Describe principles of use and storage of rod and filler wire
G. Describe the most common GMAW weldability problems associated with electrodes and filler wire
H. Illustrate GMAW filler metal classification by AWS standards/classification charts
I. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A. Discuss GMAW filler wires, fluxes, and GMAW applications
B. Perform classification exercises, given weld specifications from the instructor
C. Discuss the importance of mechanical properties, impact properties, and chemical composition of filler wires to the welding process

WLD-M11-HO2
Describe GMAW Filler Wires
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M12-HO1

Demonstrate Ability to Repair Welds

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the need to repair welds;
B. Understand the removal of discontinuity, and,
C. Repair by re-weld.

MODULE OUTLINE:

Instructional Topics:

A. Identify the type of equipment to be used, and the differences of equipment
B. Illustrate safety and preventive practices
C. Illustrate welding variables and adjustments to equipment
D. Describe the most common GMAW weldability problems
E. Illustrate GMAW filler metal classification by AWS standards
F. Illustrate GMAW filler metal by Aluminum Association Metal Classification System

Student Activities:

A, Set up procedure for GMAW process and equipment
B. Perform welds specified by instructor with various metals and filler wire using single and multi-pass welds
C. Perform welding in multiple positions
D. Determine the defect or non-conformity that can be corrected by re-weld
E. Demonstrate ability to repair welds
F. Demonstrate ability to preheat weld area if necessary

WLD-M12-HO2
Demonstrate Ability to Repair Welds
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   - a. Install adapter for particular brand of wire feeder
   - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   - c. Screw on gas defuser and tighten allen screw
   - d. Install contact tip
   - e. Install gas nozzle
   - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   - a. Compare and contrast constant current and constant voltage power sources
   - b. List effects of inductance on circuit
   - c. List effects of pinch effect
3. Shielding Gas Application
   - a. List arc characteristics caused by welding with 100% carbon dioxide
   - b. List arc characteristics caused by welding with 100% argon
   - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using [illegible] method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW [illegible] and [illegible] on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

2893

2894

Duty M2

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-M13-HO1
Demonstrate Machine Adjustments (Voltage, Amps, Wire Speed)
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the effects of variables on weld quality; and,
B. Adjust GMAW equipment to improve weld quality.

MODULE OUTLINE:

Instructor Topics:

A. Describe SMAW short circuit transfer methods
B. Emphasizes the principles involved in of GMAW machine adjustments
C. Demonstrate knowledge of voltage and amperes and their effects on welding outcomes
D. Demonstrate uses of wire and wire speed
E. Demonstrate knowledge of the proper application of welding skills
F. Identify polarity requirements using GMAW short circuit transfer on various metals
G. Increase knowledge of current industry standards and techniques
H. Identify welding variables and their effects on weld quality
I. Identify the AISI steel classification system
J. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Discuss GMAW short circuit transfer methods
B. Set machine adjustments to approved values for welding procedure
C. Preheat weld surface
D. Adjust wire feeder mechanism, as appropriate
E. Perform single pass and multi-pass welds
F. Perform welds in four positions
G. Make adjustments to improve weld quality

WLD-M13-HO2
Demonstrate Machine Adjustments (Voltage, Amps, Wire Speed)
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

  a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
  b. Choose the correct electrode for given material and applications both type and size
  c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
  a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
  b. Choose the correct electrode for given material and applications both type and size
  c. Set voltage and wire feed speed for a given application, material and material thickness

8. Weld T Joints on Carbon Steel Using GMAW Equipment
  a. Inspect area for safety
  b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
  c. Adjust the welding parameters for this task
  d. Tack a T joint using GMAW
  e. Weld 1/4" fillet welds in 2F position using string bead technique
  f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
  g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"

9. Weld Multi-Pass Fillet Welds - All Positions
  a. Inspect area for safety
  b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
  c. Adjust the welding parameters for this task
  d. Tack a T joint using GMAW
  e. Weld the second pass with electrode centered at the bottom toe of the first pass
  f. Weld the third pass with electrode centered at the top toe of the second pass
  g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
  a. Inspect area for safety
  b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
  c. Adjust the welding parameters for this task
  d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M14-HO1
Initiate Welding Process
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand codes and specifications given to produce a desired weld;
B. Understand welding techniques necessary to produce a desired weld; and,
C. Understand principles and use of short circuit transfer.

MODULE OUTLINE:

Instructor Topics:

A. Discuss applications for GMAW short circuit transfer methods
B. Emphasizes the principles involved in the operating of GMAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of codes and specifications
F. Demonstrate knowledge of the proper application of welding skills
G. Demonstrate knowledge of adequate preparation of welding surfaces
H. Increase skill level to pass certification tests offered by an employer
I. Prepare butt joints, and tee joints, for welding
J. Increase knowledge of current industry standards and techniques
G. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
L. Explain short circuit transfer events of contact, melting, separation, flattening, and recontact
M. Identify polarity requirements using GMAW short circuit transfer on various metals
N. Demonstrate preheat and how to maintain desired temperature
O. Identify welding variables and their effects on weld quality
P. Identify the AISI steel classification system
Q. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Discuss principles and use of short circuit transfer
B. Preheat weld surface
C. Perform welds in four positions
D. Use approved welding technique
E. Perform single pass and multi-pass welds
F. Make adjustments to improve weld quality

WLD-M14-HO2
Initiate Welding Process
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

e. Weld the second pass with electrode centered at the bottom toe of the first pass
f. Weld the third pass with electrode centered at the top toe of the second pass
g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M15-HO-1
Perform Weld Sequence
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Understand adequate machine adjustments; and,
B. Perform welds in various positions.

MODULE OUTLINE:

Instructor Topics:
A. Present the advantages and possible disadvantages of use of GMAW short circuit transfer methods for comparable applications.
B. Emphasizes the principles involved in the operating of GMAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Increase skill level to pass certification tests offered by an employer
H. Prepare butt joints, and tee joints, for welding
I. Increase knowledge of current industry standards and techniques
J. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
K. Identify polarity requirements using GMAW short circuit transfer on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match GMAW electrodes to an appropriate base metal

Student Activities:
A. Discuss advantages and possible disadvantages of the short circuit methods
B. Select shielding gas
C. Preheat weld surface
D. Perform welds in four positions
E. Use approved welding technique
F. Perform single pass welds with thinner metals and multi-pass welds with thicker metals
G. Make adjustments to improve weld quality

WLD-M15-HO2
Perform Weld Sequence
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M16-HO1
Control Weld Technique
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Understand weld requirements; and,
B. Understand weld techniques to produce specific welds.

MODULE OUTLINE:

Instructor Topics:
A. Emphasizes the principles involved in the operating of GMAW equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Increase skill level to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using GMAW short circuit transfer on various metals
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match GMAW electrodes to an appropriate base metal

Student Activities:
A. Preheat weld surface
B. Perform welds in four positions
C. Use approved welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-M16-HO2
Control Weld Technique
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30□ bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M17-HO1

Understand Welding Characteristics of Various Shielding Gases

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- A. Understand gas bottle safety; and,
- B. Perform welds on various metals using various shielding gas and gas mixes.

MODULE OUTLINE:

Instructor Topics:

- A. Emphasizes the principles involved in the operating of GMAW equipment
- B. Demonstrate knowledge of joint design and welding terms
- C. Demonstrate ability to interpret drawings and blueprints
- D. Demonstrate knowledge of the proper application of welding skills
- E. Demonstrate knowledge of adequate preparation of welding surfaces
- F. Increase skill level to pass qualification tests offered by an employer
- G. Prepare butt joints, and tee joints, for welding
- H. Increase knowledge of current industry standards and techniques
- I. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
- J. Identify polarity requirements using GMAW short circuit transfer on various metals
- K. Demonstrate preheat and how to maintain desired temperature
- L. Identify welding variables and their effects on weld quality
- M. Identify the AISI steel classification system
- N. Match GMAW electrodes to an appropriate base metal

Student Activities:

- A. Select approved shielding gases
- B. Preheat weld surface
- C. Perform welds in four positions
- D. Use approved and appropriate welding technique
- E. Perform single pass and multi-pass welds
- F. Make adjustments to improve weld quality

WLD-M17-HO2
Understand Welding Characteristics of Various Shielding Gases
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M18-HO1
Post-Clean Weld
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand weld surface preparation;
B. Understand the use of solvents to clean weld surfaces; and,
C. Understand the process chipping and grinding.

MODULE OUTLINE:

Instructor Topics:

A. Weld surface preparation
B. Cleaning of weld surfaces
C. Knowledge of the proper application of welding skills
D. Knowledge of current industry standards and techniques
E. Identify welding variables and their effects on weld quality
F. Identify the AISI steel classification system
G. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use approved welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality
F. Post-clean weld

WLD-M18-HO2
Post-Clean Weld
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M19-HO1
Perform Interpass Preparation
Attachment 1: MASTER **Handout** No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand welding requirements;
B. Understand the use of various tools to prepare welding surfaces; and,
C. Understand the purpose of interpass.

MODULE OUTLINE:

Instructor Topics:

A. Discuss pre-heating and maintaining interpass temperatures
B. Emphasizes the principles involved in preheating and reducing the quench rate
C. Demonstrate preheat and how to maintain desired temperature
D. Demonstrate knowledge of joint design and welding terms
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Prepare butt joints, and tee joints, for welding
G. Demonstrate knowledge of the proper application of welding skills
H. Identify the AISI steel classification system
I. Demonstrate GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
J. Increase skill level to pass certification or qualification tests offered by an employer
K. Identify polarity requirements using GMAW short circuit transfer on various metals
L. Identify welding variables and their effects on weld quality
M. Increase knowledge of current industry standards and techniques
N. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds, maintaining recommended interpass temperatures
C. Use approved welding techniques
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-M19-HO2
Perform Interpass Preparation
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

  a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
  b. Choose the correct electrode for given material and applications both type and size
  c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
  a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
  b. Choose the correct electrode for given material and applications both type and size
  c. Set voltage and wire feed speed for a given application, material and material thickness

8. Weld T Joints on Carbon Steel Using GMAW Equipment
  a. Inspect area for safety
  b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
  c. Adjust the welding parameters for this task
  d. Tack a T joint using GMAW
  e. Weld 1/4" fillet welds in 2F position using string bead technique
  f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
  g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"

9. Weld Multi-Pass Fillet Welds - All Positions
  a. Inspect area for safety
  b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
  c. Adjust the welding parameters for this task
  d. Tack a T joint using GMAW
  e. Weld the second pass with electrode centered at the bottom toe of the first pass
  f. Weld the third pass with electrode centered at the top toe of the second pass
  g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
  a. Inspect area for safety
  b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
  c. Adjust the welding parameters for this task
  d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M20-HO1

Demonstrate Short Circuit GMAW Flat Horizontal, Vertical and Overhead

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to perform welds in flat, horizontal, vertical and overhead positions using GMAW equipment.

MODULE OUTLINE:

Instructor Topics:

A. Discuss the need for specific techniques and adjustments that maximize weld quality in multiple positions
B. Emphasizes the principles involved in the weld sequence/control of basic variables and operation of GMAW equipment
C. Demonstrate knowledge of the proper application of welding skills
D. Demonstrate knowledge of adequate preparation of welding surfaces
E. Demonstrate ability to interpret drawings and blueprints
F. Demonstrate knowledge of joint design and welding terms
G. Prepare butt joints, and tee joints, for welding
H. Identify polarity requirements using GMAW short circuit transfer on various metals
I. Maximize GMAW quality using short circuit transfer in the flat, horizontal, vertical and overhead positions
J. Increase knowledge of current industry standards and techniques
K. Identify welding variables and their effects on weld quality
L. Identify the AISI steel classification system
M. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use approved welding techniques, with major consideration for safety
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   - a. Install adapter for particular brand of wire feeder
   - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   - c. Screw on gas defuser and tighten allen screw
   - d. Install contact tip
   - e. Install gas nozzle
   - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   - a. Compare and contrast constant current and constant voltage power sources
   - b. List effects of inductance on circuit
   - c. List effects of pinch effect
3. Shielding Gas Application
   - a. List arc characteristics caused by welding with 100% carbon dioxide
   - b. List arc characteristics caused by welding with 100% argon
   - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Tack a T joint using GMAW
    - e. Weld 1/4" fillet welds in 2F position using string bead technique
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    - g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Tack a T joint using GMAW
    - e. Weld the second pass with electrode centered at the bottom toe of the first pass
    - f. Weld the third pass with electrode centered at the top toe of the second pass
    - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M21-HO1
Post Finish Weld
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand welding requirements; and,
B. Understand adjustments of GMAW equipment to increase weld quality.

MODULE OUTLINE:

Instructor Topics:

A. Presents post-finish weld methods and techniques
B. Emphasizes the principles involved in the operating of GMAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Increase skill level to pass certification tests offered by an employer
H. Prepare butt joints, and tee joints, for welding
I. Increase knowledge of current industry standards and techniques
J. Maximize GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
K. Identify polarity requirements using GMAW short circuit transfer on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality
F. Post-finish weld

WLD-M21-HO2
Post Finish Weld
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

e. Weld the second pass with electrode centered at the bottom toe of the first pass
f. Weld the third pass with electrode centered at the top toe of the second pass
g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M22-HO1
Describe GMAW Filler Wires
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand filler metal related to the job requirements.

MODULE OUTLINE:

Instructor Topics:

A. Discuss the process of filler wire selection; emphasizes the principles involved in the operating of GMAW equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Increase knowledge of current industry standards and techniques
F. Maximize GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
G. Identify polarity requirements using GMAW short circuit transfer on various metals
H. Demonstrate preheat and how to maintain desired temperature
I. Identify welding variables and their effects on weld quality
J. Identify the AISI steel classification system
K. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Select, install, and adjust electrode filler wires
B. Preheat weld surface
C. Perform welds in four positions
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-M22-HO2
Describe GMAW Filler Wires
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M23-HO1
Describe Basic Weld Discontinuities
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the welders responsibilities related to discontinuities and defects;
B. Identify and define discontinuities and defects;
C. Understand causes of discontinuities related to shape, size and contour;
D. Understand causes of discontinuities related to internal inconsistencies and weld metal irregularities; and,
E. Understand common causes of discontinuities related to weld and base metal properties.

MODULE OUTLINE:

Instructor Topics:

A. Discuss the causes and prevention of weld discontinuities
B. Emphasizes the principles involved in the operating of GMAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Increase skill level to pass certification tests offered by an employer
H. Prepare butt joints, and tee joints, for welding
I. Increase knowledge of current industry standards and techniques
J. Maximize GMAW using short circuit transfer in the flat, horizontal, vertical and overhead positions
K. Identify polarity requirements using GMAW short circuit transfer on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match GMAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions
C. Use approved welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-M23-HO2
Describe Basic Weld Discontinuities
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

	Duties	Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with coworkers and supervisors						
E	Work as a Team	E-1 Understand the roles of coworkers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their affects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WLDxPM0
072396

2952

2953

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on llife of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-M24-HO1

Demonstrate Pre-Weld Cleaning

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Demonstrate the safe method of cleaning surfaces to be welded using hand tools (wire brush, power tools, etc); and,

B. Describe surface preparation procedures using cleaning solvents such as acetone.

MODULE OUTLINE:

Instructional Topics:

A. Introduction to gas metal arc with spray and pulsed spray transfer welding plate and pipe

B. Discussion on the safety and health of welders

C. A discussion on set-up, operation, and shut down procedures

D. Pre-weld cleaning methods

E. Preparation and assembly of various materials and shapes

F. Describe AISI Classification System

G. Describe the most common weldability problems with aluminum, stainless steel and carbon steel

H. Make adjustments on GMAW equipment and process to improve weld quality

I. Demonstrate visual, guided bend, and nick break test on various metals.

Student Activities:

A. Set-up welding station

B. Tack weld joints

C. Clean weld surface

D. Deposit root pass

E. Deposit multiple pass to fill groove

F. Perform guided bend and nick break test

WLD-M24-HO2
Demonstrate Pre-Weld Cleaning
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Place the T joint in the 4F overhead position approximately at eye level
   - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
   - a. Inspect the work area and equipment for safety
   - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   - c. Use grind to clean the bevel face and apply a 3/32" root face
   - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   - f. Weld root upwards
   - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   - i. Complete the second pass using GMAW and upward Z weave technique
   - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   - k. Make fourth and final pass with the same technique.
   - l. The electrode is weaved from one bevel edge to another
   - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
   - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M25-HO
Demonstrate Interpass Cleaning
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to perform material and weld cleaning after each weld pass is applied using wire brush, or power tools with or without cleaning solvents such as acetone

---

MODULE OUTLINE:

Instructional Topics:

A. Introduction to gas metal arc with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders
C. Discussion on set-up, operation, and shut down procedures
D. Discussion of interpass cleaning techniques
E. Explain and demonstrate interpass cleaning with pipe
F. Preparation and assembly of various materials and shapes
G. Describe AISI Classification System
H. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
I. Make adjustments on GMAW equipment and process to improve weld quality
J. Demonstrate visual, guided bend, and nick break test on various metals.

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Deposit root pass
E. Perform interpass cleaning
F. Deposit multiple pass to fill groove

WLD-M25-HO2
Demonstrate Interpass Cleaning
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   - e. Weld the second pass with electrode centered at the bottom toe of the first pass
   - f. Weld the third pass with electrode centered at the top toe of the second pass
   - g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   - a. Inspect area for safety
   - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   - c. Adjust the welding parameters for this task
   - d. Place the T joint in the 4F overhead position approximately at eye level
   - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
   - a. Inspect the work area and equipment for safety
   - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   - c. Use grind to clean the bevel face and apply a 3/32" root face
   - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   - f. Weld root upwards
   - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   - i. Complete the second pass using GMAW and upward Z weave technique
   - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   - k. Make fourth and final pass with the same technique.
   - l. The electrode is weaved from one bevel edge to another
   - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
   - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M26-HO1
Demonstrate Adjustment to Pulse and Spray Transfer Machines
Attachment 1: MASTER Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform welds using spray and pulsed spray transfer with FCAW, and GMAW equipment;

B. Identify weld variables in the weld quality; and,

C. Make adjustments to GMAW and FCAW equipment to improve weld quality.

MODULE OUTLINE:

Instructional Topics:

A. Discussion of pulse and spray machine adjustments

B. Discussion on the safety and health of welders

C. A discussion on set-up, operation, and shut down procedures

D. Preparation and assembly of various materials and shapes for GMAW

E. Describe AISI Classification System

F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel

G. Make adjustments on GMAW equipment and process to improve weld quality

H. Demonstrate destructive and non-destructive tests on various metals welded for pipe

Student Activities:

A. Set-up welding station

B. Perform adjustments on pulse and spray machines

C. Clean weld surface

D. Tack weld joints

E. Deposit root pass

F. Perform interpass

G. Deposit multiple pass to fill groove on various metals

H. Perform destructive and non-destructive tests

WLD-M26-HO2
Demonstrate Adjustment to Pulse and Spray Transfer Machines
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety.
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M27-HO1

Demonstrate GMAW in Flat, Horizontal, Vertical and Overhead Positions

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Prepare material for welding;
B. Place material in a designated angle to perform weld;
C. Perform weld sequence in the flat position using GMAW spray and pulsed spray transfer;
D. Perform weld sequence in the horizontal position using GMAW spray and pulsed spray transfer;
E. Perform weld sequence in the vertical position using GMAW spray and pulsed spray transfer; and,
F. Perform weld sequence in the overhead position using GMAW spray and pulsed spray transfer.

MODULE OUTLINE:

Instructional Topics:

A. Introduction to gas metal arc with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various materials and shapes
E. Describe AISI Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate non-destructive and destructive test on various metals.

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Perform flat groove and fillet welds, and horizontal fillet welds
E. Deposit root pass
F. Deposit multiple pass to fill groove
G. Perform vertical and overhead welds under the direct supervision of the instructor
H. Perform nondestructive and destructive testing

WLD-M27-HO2

Demonstrate GMAW in Flat, Horizontal, Vertical and Overhead Positions

Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M28-HO1
Pre-Heat Joint, If Required; Understand Joint Preparation
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand welding requirements for penetration and preparation of surfaces; and,
B. Perform pre-heat on 3/8 and 3/4 plus 1 inch steel and aluminum plate.

MODULE OUTLINE:

Instructional Topics:

A. Introduction to gas metal arc with spray and pulsed spray transfer, welding plate and pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various materials and shapes
E. Describe AISI Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate non-destructive and destructive testing on various metals.

Student Activities:

A. Set-up welding station
B. Pre-heat joint
C. Tack weld joints
D. Use of spray and pulsed spray arc process
E. Clean weld surface
F. Deposit root pass
G. Deposit multiple pass to fill groove and fillet on various metals
H. Perform Non-destructive and destructive tests as assigned by instructor

WLD-M28-HO2
Pre-Heat Joint, If Required; Understand Joint Preparation
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

a. Choose the correct shielding gas and flow rate for the given application, material and material thickness

b. Choose the correct electrode for given material and applications both type and size

c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M29-HO1
Initiate Welding Process
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand weld requirements from procedure;
B. Check all parameters of adjustment; and,
C. Initiate specific process from a procedure.

MODULE OUTLINE:

Instructional Topics:

A. Introduction to AISI Code requirements for GMAW for pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various materials and shapes
E. Describe AISI Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate visual, guided bend, and nick break test on various metals.
I. Perform inspection weld tests on various metals

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Perform root pass
E. Deposit multiple pass to fill groove
F. Perform guided bend and nick break test

WLD-M29-HO2
Initiate Welding Process
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M30-HO1
Perform Weld Sequence
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand sequence of welding application;
B. Test parameters of adjustment; and,
C. Make adjustments to equipment to ensure quality of welds.

MODULE OUTLINE:

Instructional Topics:

A. Practical applications using gas metal arc with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various materials and shapes
E. Describe AISI Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate visual, and recommended tests on various metals.

Student Activities:

A. Set-up welding station
B. Tack weld joints
C. Clean weld surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform recommended tests on various metals

WLD-M30-HO2
Perform Weld Sequence
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   - a. Install adapter for particular brand of wire feeder
   - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   - c. Screw on gas defuser and tighten allen screw
   - d. Install contact tip
   - e. Install gas nozzle
   - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   - a. Compare and contrast constant current and constant voltage power sources
   - b. List effects of inductance on circuit
   - c. List effects of pinch effect
3. Shielding Gas Application
   - a. List arc characteristics caused by welding with 100% carbon dioxide
   - b. List arc characteristics caused by welding with 100% argon
   - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M31-HO1
Describe AISI Stainless Steels Classification System
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand AISI code requirements.

MODULE OUTLINE:

Instructional Topics:

A. Use of GMAW with spray and pulsed spray transfer welding plate and pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures with spray techniques
D. Preparation and assembly of various alloy pipe work pieces
E. Describe AISI Stainless Steel Classification System
F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Perform inspections and weld tests on various metals

Student Activities:

A. Set-up welding station
B. Tack pipe of various alloys in 5G and 6G positions
C. Clean weld joint surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform guided bend and nick break test

WLD-M31-HO2
Describe AISI Stainless Steels Classification System
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   a. Install adapter for particular brand of wire feeder
   b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   c. Screw on gas defuser and tighten allen screw
   d. Install contact tip
   e. Install gas nozzle
   f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   a. Compare and contrast constant current and constant voltage power sources
   b. List effects of inductance on circuit
   c. List effects of pinch effect
3. Shielding Gas Application
   a. List arc characteristics caused by welding with 100% carbon dioxide
   b. List arc characteristics caused by welding with 100% argon
   c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M32-HO1
Describe Weldability Problems Associated with Straight Chromium, Nickel and Stainless Steel
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand chromium and stainless steel alloy compatibility; and,
B. Understand weldability problems with nickel.

MODULE OUTLINE:

Instructional Topics:

A. Production welding for Gas Metal Arc Welding Pipe
B. Discussion on the safety and health of welders
C. A discussion on set-up, operation, and shut down procedures
D. Preparation and assembly of various alloy pipe work pieces
E. Describe AISI Stainless Steel Classification System
F. Describe the most common weldability problems with chromium, nickel, and stainless steel
G. Make adjustments on GMAW equipment and process to improve weld quality
H. Demonstrate visual, guided bend, and nick break test on various metals.

Student Activities:

A. Set-up welding station
B. Tack pipe of various alloys in 5G and 6G positions
C. Clean weld joint surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform guided bend and nick break test

WLD-M32-HO2

Describe Weldability Problems Associated with Straight Chromium, Nickel and Stainless Steel

Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness

6. Weld With GMAW Using Globular Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Place the T joint in the 4F overhead position approximately at eye level
   e. Weld a 1/4" fillet weld (wire brush weld after each pass)
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
   a. Inspect the work area and equipment for safety
   b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
   c. Use grind to clean the bevel face and apply a 3/32" root face
   d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
   e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
   f. Weld root upwards
   g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
   h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
   i. Complete the second pass using GMAW and upward Z weave technique
   j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
   k. Make fourth and final pass with the same technique.
   l. The electrode is weaved from one bevel edge to another
   m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
   a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M33-HO1
Describe Detrimental Effects of Vibration on Life of Piping Systems
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the effects of pressure and steam on metal piping systems; and,

B. Understand the effects of vibration.

MODULE OUTLINE:

Instructional Topics:

A. Effects of pressure, steam, and vibration on piping systems

B. Gas Metal Arc Welding Pipe

C. Set-up, operation, and shut down procedures for GMAW -Pipe

D. Preparation and assembly of various alloy pipe work pieces

E. Describe AISI Stainless Steel Classification System

F. Describe the most common weldability problems with aluminum, stainless steel and carbon steel

G. The reliability of pipe welds under stress

H. Make adjustments on GMAW equipment and process to improve weld quality

I. Demonstrate recommended tests

J. Welding techniques to counteract stress and strain on pipe welds

Student Activities:

A. Set-up welding station

B. Tack pipe of various alloys in 5G and 6G positions

C. Clean weld joint surface

D. Deposit root pass

E. Deposit multiple pass to fill groove

F. Perform recommended inspections and tests on welded pipe materials

WLD-M33-HO2

Describe Detrimental Effects of Vibration on Life of Piping Systems

Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. . Assemble GMAW Gun and Name All Parts
    a. Install adapter for particular brand of wire feeder
    b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    c. Screw on gas defuser and tighten allen screw
    d. Install contact tip
    e. Install gas nozzle
    f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    a. Compare and contrast constant current and constant voltage power sources
    b. List effects of inductance on circuit
    c. List effects of pinch effect
3. Shielding Gas Application
    a. List arc characteristics caused by welding with 100% carbon dioxide
    b. List arc characteristics caused by welding with 100% argon
    c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
6. Weld With GMAW Using Globular Transfer

   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness

7. Weld With GMAW Using Pulsed Spray Transfer
   a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   b. Choose the correct electrode for given material and applications both type and size
   c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld 1/4" fillet welds in 2F position using string bead technique
   f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
   g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Tack a T joint using GMAW
   e. Weld the second pass with electrode centered at the bottom toe of the first pass
   f. Weld the third pass with electrode centered at the top toe of the second pass
   g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
   a. Inspect area for safety
   b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
   c. Adjust the welding parameters for this task
   d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M34-HO1
Describe Methods of Minimizing Detrimental Effects Of Pressure and Heat on Life of Pipe Systems
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to understand material requirements and specifications.

MODULE OUTLINE:

Instructional Topics:

A. Analysis of detrimental effects on piping systems welds
B. Use of Gas Metal Arc Welding-Pipe
C. Discussion on the safety and health of welders
D. A discussion on set-up, control of variables, operation, and shut down procedures
E. Preparation and assembly of various alloy pipe work pieces
F. Describe AISI Stainless Steel Classification System
G. Describe the most common weldability problems with aluminum, stainless steel and carbon steel
H. Make adjustments on GMAW equipment and process to improve weld quality
I. Demonstrate recommended and approved tests on pipe materials

Student Activities:

A. Set-up welding station
B. Tack pipe of various alloys in 5G and 6G positions
C. Clean weld joint surface
D. Deposit root pass
E. Deposit multiple pass to fill groove
F. Perform recommended and approved tests on pipe weldments

WLD-M34-HO2

Describe Methods of Minimizing Detrimental Effects Of Pressure and Heat on Life of Pipe Systems

Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
   - a. Install adapter for particular brand of wire feeder
   - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
   - c. Screw on gas defuser and tighten allen screw
   - d. Install contact tip
   - e. Install gas nozzle
   - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
   - a. Compare and contrast constant current and constant voltage power sources
   - b. List effects of inductance on circuit
   - c. List effects of pinch effect
3. Shielding Gas Application
   - a. List arc characteristics caused by welding with 100% carbon dioxide
   - b. List arc characteristics caused by welding with 100% argon
   - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
   - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
   - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
   - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
   - b. Choose the correct electrode for given material and applications both type and size
   - c. Set voltage and wire feed speed for a given application, material and material thickness

6. Weld With GMAW Using Globular Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Place the T joint in the 4F overhead position approximately at eye level
    e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

12. Weld Single V Groove With GMAW
    a. Inspect the work area and equipment for safety
    b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    c. Use grind to clean the bevel face and apply a 3/32" root face
    d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    f. Weld root upwards
    g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    i. Complete the second pass using GMAW and upward Z weave technique
    j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    k. Make fourth and final pass with the same technique.
    l. The electrode is weaved from one bevel edge to another
    m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges

13. Weld Pipe - 1G Position
    a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WLD-M35-HO1
Pass a Performance Qualification Test Using GMAW on Pipe in the 6G Position
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the procedures and applications for GMAW pulsed spray with pipe;
B. Learn standards and codes for piping; and,
C. With practice, pass a performance qualification test.

MODULE OUTLINE:

Instructional Topics:

A. Metal pipe materials and weld characteristics
    1. Cast iron,
    2. Low carbon or medium carbon steel
    3. Higher alloy steel
        a. Stainless steel
        b. Aluminum
B. Standards and codes for piping
    1. American Society for Testing Materials (ASTM)
    2. The American Society of Mechanical engineers (ASME)
    3. American Petroleum Institute (API)
    4. American Welding Society (AWS)
C. Spray transfer methods for GMAW
D. Use of shielding gas

Student Activities:

A. Choose the correct shielding gas and flow rate for the given application, material, and material thickness
B. Choose the correct electrode for given material and applications
C. Set voltage and wire-feed speed for a given application, material, and material thickness
D. Apply welding technique

WLD-M35-HO2
Pass a Performance Qualification Test
Using GMAW on Pipe in the 6G Position
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS METAL ARC WELDING (GMAW)

1. Assemble GMAW Gun and Name All Parts
    - a. Install adapter for particular brand of wire feeder
    - b. Insert liner of correct size until liner gasket meets adapter and tighten allen screw
    - c. Screw on gas defuser and tighten allen screw
    - d. Install contact tip
    - e. Install gas nozzle
    - f. Adjust gun for tip to work distance
2. Understand Gas Metal Arc Power Source
    - a. Compare and contrast constant current and constant voltage power sources
    - b. List effects of inductance on circuit
    - c. List effects of pinch effect
3. Shielding Gas Application
    - a. List arc characteristics caused by welding with 100% carbon dioxide
    - b. List arc characteristics caused by welding with 100% argon
    - c. List arc characteristics caused by welding with 75% Argon and 25% CO2
    - d. List arc characteristics caused by welding with 95% Argon and 5% CO2
    - e. List arc characteristics caused by welding with 95% Argon and 5% oxygen
4. Weld With GMAW Using Spray Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness
5. Weld With GMAW Using Short Circuit Transfer
    - a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    - b. Choose the correct electrode for given material and applications both type and size
    - c. Set voltage and wire feed speed for a given application, material and material thickness

6. Weld With GMAW Using Globular Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
7. Weld With GMAW Using Pulsed Spray Transfer
    a. Choose the correct shielding gas and flow rate for the given application, material and material thickness
    b. Choose the correct electrode for given material and applications both type and size
    c. Set voltage and wire feed speed for a given application, material and material thickness
8. Weld T Joints on Carbon Steel Using GMAW Equipment
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld 1/4" fillet welds in 2F position using string bead technique
    f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
    g. Change weld size once proficiency is reached on 6. to 3/16" go to step 1 then 5/16"
9. Weld Multi-Pass Fillet Welds - All Positions
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Tack a T joint using GMAW
    e. Weld the second pass with electrode centered at the bottom toe of the first pass
    f. Weld the third pass with electrode centered at the top toe of the second pass
    g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
10. Weld Multi-Pass Fillet Welds - 3F Vertical Position
    a. Inspect area for safety
    b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    c. Adjust the welding parameters for this task
    d. Position the T joint in the 3F position for vertical welding. Weld a 1/4" fillet in the vertical position, upward using a slight weave technique

- e. Weld the second pass with electrode centered at the bottom toe of the first pass
- f. Weld the third pass with electrode centered at the top toe of the second pass
- g. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1

11. Weld Multi-Pass Fillet Welds - 4F Overhead Position
    - a. Inspect area for safety
    - b. Use oxy-fuel gas cutting equipment cut two 1/4" X 3" X 10" pieces of carbon steel
    - c. Adjust the welding parameters for this task
    - d. Place the T joint in the 4F overhead position approximately at eye level
    - e. Weld a 1/4" fillet weld (wire brush weld after each pass)
    - f. Visual test welds for size, equal legs, acceptable weld profile to AWS D1.1
12. Weld Single V Groove With GMAW
    - a. Inspect the work area and equipment for safety
    - b. Use oxy-fuel cutting equipment cut and bevel two pieces of 3/8" X 3" X15" with 30° bevel angle
    - c. Use grind to clean the bevel face and apply a 3/32" root face
    - d. Adjust GMAW equipment to run .035" ER70S-3 with 75% Argon 25% CO2 shielding gas at a flow rate of 30 cubic feet per hour at approximately 16 arc volts and 100 amps
    - e. Using GMAW the two pieces are tacked together to produce a single V groove with a 1/8" root opening
    - f. Weld root upwards
    - g. Visual inspect finished root bead after wire brushing. Any high spots and lack of fusion are removed by grinding.
    - h. Using GMAW and upward Z weave technique the second weld pass is applied. The electrode is moved from one root pass to the other with a slight upward motion
    - i. Complete the second pass using GMAW and upward Z weave technique
    - j. Using GMAW and on upward Z weave technique the third pass is welded. The electrode is moved from the left toe of the second pass to the right toe on back. Each weave is accompanied by a slight upward motion. Be careful not to burn away the bevel edges
    - k. Make fourth and final pass with the same technique.
    - l. The electrode is weaved from one bevel edge to another
    - m. Visually inspect weld. The root reinforcement shall extend 1/16" above the base metal, have good fusion etc. The weld face shall meet D1.1 requirements and have parallel and straight edges
13. Weld Pipe - 1G Position
    - a. Fit up and tack pipe according to given tolerances

b. Adjust wire feeder drive system
c. Adjust shielding gas system and flow rate
d. Adjust GMAW gun to allow proper tip to work distance and gas coverage
e. Set welding condition for spray transfer - Wire Feed Speed
f. Set welding condition for short circuit transfer - Voltage
g. Set welding condition for short circuit transfer - Tip to Work Distance
h. Weld using roll welding technique

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe aluminum [illegible] metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

Duty N

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
M2 GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3 GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1 Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2 Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U Wellness/Physical Abilities	U-1 Demonstrate ability to lift 60 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-N1-HO
Understand the Safety Factors Using FCAW Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform safety inspection of work area;
B. Identify an unsafe work environment;
C. Understand the use of protective equipment and clothing; and,
D. Utilize FCAW equipment in a safe manner.

MODULE OUTLINE:

Instructor Topics:

A. Emphasize potential safety hazards with FCAW equipment
B. Emphasizes the principles involved in the operating of FCAW equipment
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Increase skill level to pass certification tests offered by an employer
H. Prepare butt joints, and tee joints, for welding
I. Increase knowledge of current industry standards and techniques
J. Demonstrate FCAW in the flat, horizontal, vertical and overhead positions
K. Identify polarity requirements using FCAW on various metals
L. Demonstrate preheat and how to maintain desired temperature
M. Identify welding variables and their effects on weld quality
N. Identify the AISI steel classification system
O. Match FCAW electrodes to an appropriate base metal

Student Activities:

A. Identify all FCAW components and analyze them for potential safety hazards
B. Preheat weld surface
C. How to perform welds in four positions recommend and approved
D. How to use larger diameter flux cored electrodes for flat or horizontal filler welds only and use smaller diameter electrodes for all positions
E. Perform single pass and multi-pass welds
F. Make adjustments to improve weld quality

WLD-N2-HO
Troubleshoot FCAW Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform inspection of shielded and self-shielded FCAW equipment;
B. Perform equipment adjustments and repair;
C. Understand principles of FCAW process; and,
D. Understand terms and definitions.

MODULE OUTLINE:

Instructor Topics:

A. Discuss the principles involved in the operating of FCAW equipment
B. Present differences in SMAW, GMAW, and FCAW
C. Demonstrate set up of equipment and machine adjustments
D. Demonstrate applications of joint design and welding terms
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Prepare butt joints, and tee joints, for welding
G. Match FCAW electrodes to an appropriate base metal
H. Discuss electrode extension
I. Identify polarity requirements using FCAW on various metals
J. Identify the AISI steel classification system
K. Demonstrate FCAW in the flat, horizontal, vertical and overhead positions

Student Activities:

A. Perform machine set up and troubleshooting
B. Practice using FCAW tubular electrode wire
C. Practice with proper electrode extension
D. Preheat weld surface
E. Perform welds in four positions
F. Make adjustments to improve weld quality

WLD-N3-HO
Perform Weld Sequence
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Review safety requirements;
B. Perform Flux Core Arc Welding on steel and stainless steel in the flat, horizontal, vertical, and overhead position; and,
C. Practice FCAW using local industry standards as guidelines.

MODULE OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of FCAW equipment
B. Discuss the use of the FCAW flux cored tubular electrode
C. Demonstrate knowledge of joint design and welding terms
D. Demonstrate ability to interpret drawings and blueprints
E. Demonstrate knowledge of the proper application of welding skills the FCAW
F. Demonstrate knowledge of adequate preparation of welding surfaces
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Use larger electrodes in flat and horizontal positions only
J. Demonstrate FCAW in the flat, horizontal, vertical and overhead positions (using smaller diameter electrodes for vertical and overhead)
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify polarity requirements using FCAW
N. Identify the AISI steel classification system
O. Match FCAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Use proper electrode extension
C. Perform welds in four positions
D. Use recommended and approved welding technique
E. Perform single pass and multi-pass welds
F. Make adjustments to improve weld quality

WLD-N4-HO
Shut Down FCAW Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand shut-down procedures with FCAW equipment; and
B. Perform shut-down procedures with FCAW equipment.

MODULE OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of FCAW equipment
B. Sequence of procedures for equipment shutdown
C. Securing of equipment
D. Safe maintenance and repair of equipment

Student Activities:

A. Shut down equipment, following approved sequence
B. Inspect for safety and make necessary repairs
C. Safely secure and store equipment

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

	Duties	Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and groove welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post-finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on llife of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

[illegible]

WLD-O1-HO1

Identify GTAW Equipment

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand GTAW equipment identification; and,
B. Understand shielding gas equipment.

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Identify GTAW equipment
D. Troubleshoot and make minor repairs
E. Identify the AWS GTAW filler metal classification systems
F. Match filler electrodes to base metals
G. Identify GTAW welding variables and their effects on weld quality

Student Activities:

A. Set up GTAW equipment, identifying all components
B. Start up equipment, emphasizing safe procedures
C. Make adjustments to GTAW equipment and understand process steps to be followed
D. GTAW fillet and groove welds on T and butt-joints on various metals in various positions
E. Perform in process weld inspection

WLD-O1-HO2
Identify GTAW Equipment
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    a. List advantages and disadvantages of GTAW
    b. List five applications where GTAW or PAW are better suited
    c. List give applications which are more suited to SMAW than GTAW
    d. Compare and contrast GTAW and plasma arc welding (PAC)
    e. List by name the parts of a GTAW torch
    f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 2F position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 3F vertical position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 4F overhead position

    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
    a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
    b. Prepare tungsten for given procedure
    c. Set up GTAW torch for given procedure
    d. Set current for procedure
    e. Adjust shielding gas flow rate
    f. Weld root using free hand technique and using the walking the cup method
    g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    a. Use non-low hydrogen electrodes
    b. Strike arc and hold long arc length 1" away from last weld crater
    c. Back-up to previous weld crater holding long arc length
    d. Pre-heat crater with long arc
    e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    a. Use low hydrogen electrodes
    b. Strike arc 1" from crater
    c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    a. List the names and draw side views of the five basic joint configurations
    b. List the names and draw side views of the variations of grooves
    c. List the names and draw side views of the T-Joint variations
    d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    b. Clean bevel face with grinder as required
    c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

    a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
    b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
    c. List the polarity that air carbon arc is run on
    d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
    e. Connect air carbon torch arc and compressed air hose to welding machine
    f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    a. Locate root of weld
    b. Demonstrate control of depth of cut
    c. Demonstrate control of width of cut
    d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    e. Make gouges of uniform depth
    f. Observe discontinuities as gouging proceeds
    g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    b. Measure to make sure excavation is at proper location and depth
    c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    a. Check area for safety
    b. Set SMAW equipment current and polarity for 1/8" E7018
    c. Attach work lead
    d. Preheat and maintain interpass temperature as required
    e. Weld first pass paying special attention to low hydrogen techniques
    f. Grind the weld start and stop to remove cold lap and lack of fusion
    g. Weld the second pass starting from opposite end
    h. Repeat starts and stops until weld is completed
    i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    a. Check work area for safety
    b. Position steel in a T joint and tack at ends
    c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

WLD-O2-HO1

Identify the Safety Standards

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand GTAW principles of operation; and,
B. Understand storage and safe handling of inert shielding gas.

PRESENTATION OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the types of shielding gas and gas mixtures
C. Identify GTAW equipment and possible safety hazards
D. Electrode holder assembly
E. Compressed gas cylinders and flow meters
F. Storage and handling of shielding gases (argon, helium)
G. Welding power sources and safe range of operations
H. Safe trouble-shooting and repair methods

Student Activities:

A. Inspect all equipment with safety as a major consideration
B. Set up and test GTAW equipment for safe operation
C. Perform a hazards analysis of the workplace

WLD-O2-HO2
Identify the Safety Standards
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    - a. List advantages and disadvantages of GTAW
    - b. List five applications where GTAW or PAW are better suited
    - c. List give applications which are more suited to SMAW than GTAW
    - d. Compare and contrast GTAW and plasma arc welding (PAC)
    - e. List by name the parts of a GTAW torch
    - f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    - g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    - a. Conduct safety inspection of the area and equipment
    - b. Weld on 304 stainless steel
    - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    - d. Cut stainless steel to .050" X 2" X 10"
    - e. Fit up and tack a T joint and place in the 2F position
    - f. Weld a .050" fillet weld using .045" ER308-L
    - g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    - a. Conduct safety inspection of the area and equipment
    - b. Weld on 304 stainless steel
    - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    - d. Cut stainless steel to .050" X 2" X 10"
    - e. Fit up and tack a T joint and place in the 3F vertical position
    - f. Weld a .050" fillet weld using .045" ER308-L
    - g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    - a. Conduct safety inspection of the area and equipment
    - b. Weld on 304 stainless steel
    - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    - d. Cut stainless steel to .050" X 2" X 10"
    - e. Fit up and tack a T joint and place in the 4F overhead position

    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

   a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   b. Cut stainless steel and grind a .30" bevel on edges
   c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
   a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
   b. Prepare tungsten for given procedure
   c. Set up GTAW torch for given procedure
   d. Set current for procedure
   e. Adjust shielding gas flow rate
   f. Weld root using free hand technique and using the walking the cup method
   g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
   a. Use non-low hydrogen electrodes
   b. Strike arc and hold long arc length 1" away from last weld crater
   c. Back-up to previous weld crater holding long arc length
   d. Pre-heat crater with long arc
   e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
   a. Use low hydrogen electrodes
   b. Strike arc 1" from crater
   c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
   d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
   a. List the names and draw side views of the five basic joint configurations
   b. List the names and draw side views of the variations of grooves
   c. List the names and draw side views of the T-Joint variations
   d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
   a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
   b. Clean bevel face with grinder as required
   c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

   a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
   b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
   c. List the polarity that air carbon arc is run on
   d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
   e. Connect air carbon torch arc and compressed air hose to welding machine
   f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
   a. Locate root of weld
   b. Demonstrate control of depth of cut
   c. Demonstrate control of width of cut
   d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
   e. Make gouges of uniform depth
   f. Observe discontinuities as gouging proceeds
   g. Gouge until some weld metal is reached

16. Gouge to Excavate Defect
   a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
   b. Measure to make sure excavation is at proper location and depth
   c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
   d. Clean area of all scale, carbon etc.

17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
   a. Check area for safety
   b. Set SMAW equipment current and polarity for 1/8" E7018
   c. Attach work lead
   d. Preheat and maintain interpass temperature as required
   e. Weld first pass paying special attention to low hydrogen techniques
   f. Grind the weld start and stop to remove cold lap and lack of fusion
   g. Weld the second pass starting from opposite end
   h. Repeat starts and stops until weld is completed
   i. Inspect and submit for non-destructive testing RT or UT

18. Produce Fillet Weld on Sheet Steel T Joints
   a. Check work area for safety
   b. Position steel in a T joint and tack at ends
   c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
   d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
   e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

WLD-O3-HO1

Describe the Preventive and Protective Measures

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify to gas tungsten arc welding components;
B. Use shielding gas equipment and accessories component identification;
C. Demonstrate the functions gas tungsten arc welding components;
D. Provide demonstrations in the use of protective clothing and preventive action arc welding equipment and accessories;
E. Perform minor external repairs on shielding gas equipment and accessories; and,
F. Understand and prevent injury from electric shock, fires, explosions, lack of ventilation, and exposure to infrared and ultraviolet radiation.

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance of using shielding gas mixtures in a safe manner
C. Identify GTAW equipment, and areas of greatest potential hazards
D. Discuss safe and unsafe methods of operation
E. Troubleshoot and make minor repairs
F. Matching of electrodes to base metals
G. Identify the AWS GTAW filler metal classification systems
H. Identify GTAW welding variables and their effects on weld quality

Student Activities:

A. Wear protective equipment
B. Follow preventive and protective measures
C. Set up GTAW equipment
D. Make adjustments to GTAW equipment and process to improve weld quality
E. Make repairs assigned by instructor

WLD-O3-HO2
Describe the Preventive and Protective Measures
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    a. List advantages and disadvantages of GTAW
    b. List five applications where GTAW or PAW are better suited
    c. List give applications which are more suited to SMAW than GTAW
    d. Compare and contrast GTAW and plasma arc welding (PAC)
    e. List by name the parts of a GTAW torch
    f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 2F position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 3F vertical position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 4F overhead position

    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

   - a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   - b. Cut stainless steel and grind a .30" bevel on edges
   - c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   - d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   - e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
   - a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
   - b. Prepare tungsten for given procedure
   - c. Set up GTAW torch for given procedure
   - d. Set current for procedure
   - e. Adjust shielding gas flow rate
   - f. Weld root using free hand technique and using the walking the cup method
   - g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    - a. Use non-low hydrogen electrodes
    - b. Strike arc and hold long arc length 1" away from last weld crater
    - c. Back-up to previous weld crater holding long arc length
    - d. Pre-heat crater with long arc
    - e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    - a. Use low hydrogen electrodes
    - b. Strike arc 1" from crater
    - c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    - d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    - a. List the names and draw side views of the five basic joint configurations
    - b. List the names and draw side views of the variations of grooves
    - c. List the names and draw side views of the T-Joint variations
    - d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    - a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    - b. Clean bevel face with grinder as required
    - c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

- a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
- b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
- c. List the polarity that air carbon arc is run on
- d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
- e. Connect air carbon torch arc and compressed air hose to welding machine
- f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    - a. Locate root of weld
    - b. Demonstrate control of depth of cut
    - c. Demonstrate control of width of cut
    - d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    - e. Make gouges of uniform depth
    - f. Observe discontinuities as gouging proceeds
    - g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    - a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    - b. Measure to make sure excavation is at proper location and depth
    - c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    - d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    - a. Check area for safety
    - b. Set SMAW equipment current and polarity for 1/8" E7018
    - c. Attach work lead
    - d. Preheat and maintain interpass temperature as required
    - e. Weld first pass paying special attention to low hydrogen techniques
    - f. Grind the weld start and stop to remove cold lap and lack of fusion
    - g. Weld the second pass starting from opposite end
    - h. Repeat starts and stops until weld is completed
    - i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    - a. Check work area for safety
    - b. Position steel in a T joint and tack at ends
    - c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    - d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    - e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

WLD-O4-HO1

Identify the Welding Variables and Their Effects Upon Weld Quality

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide instruction in gas tungsten arc welding principles of operation;
B. Understand shielding gases as related to the gas tungsten arc welding process;
C. Understand the performance and functions of aluminum and stainless steel shapes, and identification/selection;
D. Perform tungsten electrode identification/selection for plain carbon steel, aluminum and stainless steel;
E. Perform gas tungsten arc welding filler metal identification/selection for plain carbon steel, aluminum, and stainless steel; and,
F. Understand gas tungsten arc welding principles of operation, aluminum and stainless steel weldability, and filler metal classification portion of a summative closed book examination.

PRESENTATION OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Identify GTAW equipment
D. Troubleshoot and make minor repairs
E. Match electrodes to base metals
F. Identify the AWS GTAW filler metal classification systems
G. The GTAW process
H. Identify GTAW welding variables and their effects on weld quality

Student Activities:

A. Identify weld variables and plan their input settings and control for quality outcomes
B. Input of variables (setting and controls) for specific welds
C. Make adjustments to GTAW equipment and process to improve weld quality
D. Set up GTAW equipment
E. Perform in process weld inspection
F. Perform in process rework (if required)
G. Discuss weld

WLD-O4-HO2
Identify the Welding Variables and Their Effects Upon Weld Quality
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    - a. List advantages and disadvantages of GTAW
    - b. List five applications where GTAW or PAW are better suited
    - c. List give applications which are more suited to SMAW than GTAW
    - d. Compare and contrast GTAW and plasma arc welding (PAC)
    - e. List by name the parts of a GTAW torch
    - f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    - g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    - a. Conduct safety inspection of the area and equipment
    - b. Weld on 304 stainless steel
    - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    - d. Cut stainless steel to .050" X 2" X 10"
    - e. Fit up and tack a T joint and place in the 2F position
    - f. Weld a .050" fillet weld using .045" ER308-L
    - g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    - a. Conduct safety inspection of the area and equipment
    - b. Weld on 304 stainless steel
    - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    - d. Cut stainless steel to .050" X 2" X 10"
    - e. Fit up and tack a T joint and place in the 3F vertical position
    - f. Weld a .050" fillet weld using .045" ER308-L
    - g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    - a. Conduct safety inspection of the area and equipment
    - b. Weld on 304 stainless steel
    - c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    - d. Cut stainless steel to .050" X 2" X 10"
    - e. Fit up and tack a T joint and place in the 4F overhead position

f. Weld a .050" fillet weld using .045" ER308-L
g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

   a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   b. Cut stainless steel and grind a .30" bevel on edges
   c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
   a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
   b. Prepare tungsten for given procedure
   c. Set up GTAW torch for given procedure
   d. Set current for procedure
   e. Adjust shielding gas flow rate
   f. Weld root using free hand technique and using the walking the cup method
   g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
   a. Use non-low hydrogen electrodes
   b. Strike arc and hold long arc length 1" away from last weld crater
   c. Back-up to previous weld crater holding long arc length
   d. Pre-heat crater with long arc
   e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
   a. Use low hydrogen electrodes
   b. Strike arc 1" from crater
   c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
   d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
   a. List the names and draw side views of the five basic joint configurations
   b. List the names and draw side views of the variations of grooves
   c. List the names and draw side views of the T-Joint variations
   d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
   a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
   b. Clean bevel face with grinder as required
   c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

- a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
- b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
- c. List the polarity that air carbon arc is run on
- d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
- e. Connect air carbon torch arc and compressed air hose to welding machine
- f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    - a. Locate root of weld
    - b. Demonstrate control of depth of cut
    - c. Demonstrate control of width of cut
    - d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    - e. Make gouges of uniform depth
    - f. Observe discontinuities as gouging proceeds
    - g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    - a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    - b. Measure to make sure excavation is at proper location and depth
    - c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    - d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    - a. Check area for safety
    - b. Set SMAW equipment current and polarity for 1/8" E7018
    - c. Attach work lead
    - d. Preheat and maintain interpass temperature as required
    - e. Weld first pass paying special attention to low hydrogen techniques
    - f. Grind the weld start and stop to remove cold lap and lack of fusion
    - g. Weld the second pass starting from opposite end
    - h. Repeat starts and stops until weld is completed
    - i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    - a. Check work area for safety
    - b. Position steel in a T joint and tack at ends
    - c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    - d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    - e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

WLD-O5-HO1
Troubleshoot Equipment
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Provide safety tour and orientation to gas tungsten arc welding equipment and accessories, and shielding gas equipment and accessories;
B. Provide demonstrations related to ANSI Z49.1, ***Safety in Welding, Cutting and Allied Processes, Part II - Specific Processes, 11. Arc Welding and Cutting Equipment Safety***
C. Provide demonstrations related to routine safety inspections of protective equipment and clothing, gas tungsten arc welding equipment and accessories, shielding gas equipment and accessories, required tools and the work area
D. Introduce related terms and definitions
E. Observe trainee conducting safety inspections
F. Observe trainee following safe practices
G. Observe trainee using proper terms and definitions

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify GTAW equipment
C. Inspection and safe trouble-shooting procedures for all equipment
D. Safety and handling shielding gas mixtures/containers
E. The welding power source configuration
F. How to prevent aspiration of outside atmosphere into the shielding gas
G. Gas flow rates
H. Make minor repairs
I. Electrode diameters and penetration patterns
J. Problems with weld quality related to equipment

Student Activities:

A. Set up GTAW equipment
B. Make adjustments to GTAW equipment and individual techniques to improve weld quality
C. Perform GTAW fillet and groove welds on T fillet and butt-joints on various metals in various positions
D. Perform in process weld inspection
E. Perform in process rework (if required)

WLD-O5-HO2
Troubleshoot Equipment
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    a. List advantages and disadvantages of GTAW
    b. List five applications where GTAW or PAW are better suited
    c. List give applications which are more suited to SMAW than GTAW
    d. Compare and contrast GTAW and plasma arc welding (PAC)
    e. List by name the parts of a GTAW torch
    f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 2F position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 3F vertical position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 4F overhead position

    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
b. Cut stainless steel and grind a .30" bevel on edges
c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
   a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
   b. Prepare tungsten for given procedure
   c. Set up GTAW torch for given procedure
   d. Set current for procedure
   e. Adjust shielding gas flow rate
   f. Weld root using free hand technique and using the walking the cup method
   g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    a. Use non-low hydrogen electrodes
    b. Strike arc and hold long arc length 1" away from last weld crater
    c. Back-up to previous weld crater holding long arc length
    d. Pre-heat crater with long arc
    e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    a. Use low hydrogen electrodes
    b. Strike arc 1" from crater
    c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    a. List the names and draw side views of the five basic joint configurations
    b. List the names and draw side views of the variations of grooves
    c. List the names and draw side views of the T-Joint variations
    d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    b. Clean bevel face with grinder as required
    c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

    a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
    b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
    c. List the polarity that air carbon arc is run on
    d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
    e. Connect air carbon torch arc and compressed air hose to welding machine
    f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    a. Locate root of weld
    b. Demonstrate control of depth of cut
    c. Demonstrate control of width of cut
    d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    e. Make gouges of uniform depth
    f. Observe discontinuities as gouging proceeds
    g. Gouge until some weld metal is reached

16. Gouge to Excavate Defect
    a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    b. Measure to make sure excavation is at proper location and depth
    c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    d. Clean area of all scale, carbon etc.

17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    a. Check area for safety
    b. Set SMAW equipment current and polarity for 1/8" E7018
    c. Attach work lead
    d. Preheat and maintain interpass temperature as required
    e. Weld first pass paying special attention to low hydrogen techniques
    f. Grind the weld start and stop to remove cold lap and lack of fusion
    g. Weld the second pass starting from opposite end
    h. Repeat starts and stops until weld is completed
    i. Inspect and submit for non-destructive testing RT or UT

18. Produce Fillet Weld on Sheet Steel T Joints
    a. Check work area for safety
    b. Position steel in a T joint and tack at ends
    c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

WLD-O6-HO1
Describe AWS Electrode Classification System
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

- A. Understand AWS Electrode Classification System; and,
- B. Understand "filler metal to parent metal" compatibility.

MODULE OUTLINE:

Instructional Topics:

- A. Summary of safety precautions
- B. Describe the AWS Electrode Classification System
- C. Identify the importance and variations of shielding gas mixtures and filler metal
- D. Identify GTAW equipment
- E. Types of "non-consumable" tungsten electrodes
- F. Describe the possible effects on weld quality of electrode selection
- G. Identify resources for research on metallurgy and metals compatibility
- H. Describe Classification Systems information available from professional sources and government sources
- I. Describe Library/computer software/internet resource materials

Student Activities:

- A. Understand the purpose of metals classification and proper filler metal selection
- B. Prepare GTAW equipment with various tungsten electrodes
- C. Make adjustments to GTAW equipment and process to improve weld quality
- D. Select the weld materials required based on job requirements or specification
- E. Perform weld inspection following use of different sized electrodes

WLD-O6-HO2

Describe AWS Electrode Classification System

Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    a. List advantages and disadvantages of GTAW
    b. List five applications where GTAW or PAW are better suited
    c. List give applications which are more suited to SMAW than GTAW
    d. Compare and contrast GTAW and plasma arc welding (PAC)
    e. List by name the parts of a GTAW torch
    f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 2F position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 3F vertical position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 4F overhead position

    - f. Weld a .050" fillet weld using .045" ER308-L
    - g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
    - a. Conduct safety inspection of the area and equipment
    - b. Weld on 304 stainless steel
    - c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    - d. Cut stainless steel and grind a .30" bevel on edges
    - e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    - f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    - g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    - a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    - b. Cut stainless steel and grind a .30" bevel on edges
    - c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    - d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    - e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    - a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    - b. Cut stainless steel and grind a .30" bevel on edges
    - c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    - d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    - e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

   a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   b. Cut stainless steel and grind a .30" bevel on edges
   c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
   a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
   b. Prepare tungsten for given procedure
   c. Set up GTAW torch for given procedure
   d. Set current for procedure
   e. Adjust shielding gas flow rate
   f. Weld root using free hand technique and using the walking the cup method
   g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
   a. Use non-low hydrogen electrodes
   b. Strike arc and hold long arc length 1" away from last weld crater
   c. Back-up to previous weld crater holding long arc length
   d. Pre-heat crater with long arc
   e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
   a. Use low hydrogen electrodes
   b. Strike arc 1" from crater
   c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
   d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
   a. List the names and draw side views of the five basic joint configurations
   b. List the names and draw side views of the variations of grooves
   c. List the names and draw side views of the T-Joint variations
   d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
   a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
   b. Clean bevel face with grinder as required
   c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
c. List the polarity that air carbon arc is run on
d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
e. Connect air carbon torch arc and compressed air hose to welding machine
f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
   a. Locate root of weld
   b. Demonstrate control of depth of cut
   c. Demonstrate control of width of cut
   d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
   e. Make gouges of uniform depth
   f. Observe discontinuities as gouging proceeds
   g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
   a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
   b. Measure to make sure excavation is at proper location and depth
   c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
   d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
   a. Check area for safety
   b. Set SMAW equipment current and polarity for 1/8" E7018
   c. Attach work lead
   d. Preheat and maintain interpass temperature as required
   e. Weld first pass paying special attention to low hydrogen techniques
   f. Grind the weld start and stop to remove cold lap and lack of fusion
   g. Weld the second pass starting from opposite end
   h. Repeat starts and stops until weld is completed
   i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
   a. Check work area for safety
   b. Position steel in a T joint and tack at ends
   c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
   d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
   e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

WLD-O7-HO1
Describe AWS Filler Metal Classification System
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand compatibility of filler metal to parent metal; and,

B. Use the AWS Filler Metal Classification System.

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions

B. Discuss shielding gas and filler metal selection

C. Identify the AWS GTAW filler metal classification systems

D. Identify GTAW equipment and the process of introducing the use of filler metal

E. Identify the effects of filler metal on weld quality

F. Metallurgy and metals characteristics of most popular metals

Student Activities:

A. Set up GTAW equipment

B. Use AWS filler metal alloy charts

C. Perform in process weld inspection

D. Make adjustments to GTAW equipment and process to improve weld quality

E. Perform in process rework (if required)

WLD-O7-HO2
Describe AWS Filler Metal Classification System
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
   a. List advantages and disadvantages of GTAW
   b. List five applications where GTAW or PAW are better suited
   c. List give applications which are more suited to SMAW than GTAW
   d. Compare and contrast GTAW and plasma arc welding (PAC)
   e. List by name the parts of a GTAW torch
   f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
   g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
   a. Conduct safety inspection of the area and equipment
   b. Weld on 304 stainless steel
   c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   d. Cut stainless steel to .050" X 2" X 10"
   e. Fit up and tack a T joint and place in the 2F position
   f. Weld a .050" fillet weld using .045" ER308-L
   g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
   a. Conduct safety inspection of the area and equipment
   b. Weld on 304 stainless steel
   c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   d. Cut stainless steel to .050" X 2" X 10"
   e. Fit up and tack a T joint and place in the 3F vertical position
   f. Weld a .050" fillet weld using .045" ER308-L
   g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
   a. Conduct safety inspection of the area and equipment
   b. Weld on 304 stainless steel
   c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
   d. Cut stainless steel to .050" X 2" X 10"
   e. Fit up and tack a T joint and place in the 4F overhead position

    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
    a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
    b. Prepare tungsten for given procedure
    c. Set up GTAW torch for given procedure
    d. Set current for procedure
    e. Adjust shielding gas flow rate
    f. Weld root using free hand technique and using the walking the cup method
    g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    a. Use non-low hydrogen electrodes
    b. Strike arc and hold long arc length 1" away from last weld crater
    c. Back-up to previous weld crater holding long arc length
    d. Pre-heat crater with long arc
    e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    a. Use low hydrogen electrodes
    b. Strike arc 1" from crater
    c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    a. List the names and draw side views of the five basic joint configurations
    b. List the names and draw side views of the variations of grooves
    c. List the names and draw side views of the T-Joint variations
    d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    b. Clean bevel face with grinder as required
    c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
c. List the polarity that air carbon arc is run on
d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
e. Connect air carbon torch arc and compressed air hose to welding machine
f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    a. Locate root of weld
    b. Demonstrate control of depth of cut
    c. Demonstrate control of width of cut
    d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    e. Make gouges of uniform depth
    f. Observe discontinuities as gouging proceeds
    g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    b. Measure to make sure excavation is at proper location and depth
    c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    a. Check area for safety
    b. Set SMAW equipment current and polarity for 1/8" E7018
    c. Attach work lead
    d. Preheat and maintain interpass temperature as required
    e. Weld first pass paying special attention to low hydrogen techniques
    f. Grind the weld start and stop to remove cold lap and lack of fusion
    g. Weld the second pass starting from opposite end
    h. Repeat starts and stops until weld is completed
    i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    a. Check work area for safety
    b. Position steel in a T joint and tack at ends
    c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

WLD-O8-HO1
Perform GTAW Fillet and Groove Welds on T and Butt Joints On Various Metals in Various Positions
Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform gas tungsten arc welding equipment operations;
B. Understand gas tungsten arc welding principles of operations;
C. Understand and control common process variables for gas tungsten arc welding;
D. Start and maintain an arc on plain carbon steel, using applicable filler metal and shielding gas;
E. Start and maintain an arc on aluminum, using applicable filler metal and shielding gas;
F. Start and maintain an arc on stainless steel, using applicable filler metal and shielding gas;
G. Perform flat, single pass, surfacing welds, on plain carbon steel, using applicable filler metal and shielding gas;
H. Perform flat, single pass, surfacing welds, on aluminum, using applicable filler metal and shielding gas;
I. Perform flat, single pass, surfacing welds, on stainless steel, using applicable filler metal and shielding gas; and,
J. Following safe GTAW practices.

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Identify the AWS GTAW filler metal classification systems
D. Identify GTAW welding variables and their effects on weld quality
E. Match electrodes or filler metals to base metals
F. Use GTAW equipment in a safe and effective manner
G. Troubleshoot and make minor repairs

Student Activities:

A. Set up GTAW equipment for welding
B. Make adjustments to GTAW equipment and process to improve weld quality
C. Perform GTAW fillet and groove welds on T fillet and butt-joints on various metals in various positions
D. Perform in process weld inspection
E. Perform in process rework (if required)

F. Perform other weld exercises in student handbook as recommended by instructor

WLD-O8-HO2
Perform GTAW Fillet and Groove Welds on T and Butt Joints On Various Metals in Various Positions
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    a. List advantages and disadvantages of GTAW
    b. List five applications where GTAW or PAW are better suited
    c. List give applications which are more suited to SMAW than GTAW
    d. Compare and contrast GTAW and plasma arc welding (PAC)
    e. List by name the parts of a GTAW torch
    f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 2F position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 3F vertical position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"

    e. Fit up and tack a T joint and place in the 4F overhead position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
    a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
    b. Prepare tungsten for given procedure
    c. Set up GTAW torch for given procedure
    d. Set current for procedure
    e. Adjust shielding gas flow rate
    f. Weld root using free hand technique and using the walking the cup method
    g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    a. Use non-low hydrogen electrodes
    b. Strike arc and hold long arc length 1" away from last weld crater
    c. Back-up to previous weld crater holding long arc length
    d. Pre-heat crater with long arc
    e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    a. Use low hydrogen electrodes
    b. Strike arc 1" from crater
    c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    a. List the names and draw side views of the five basic joint configurations
    b. List the names and draw side views of the variations of grooves
    c. List the names and draw side views of the T-Joint variations
    d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    b. Clean bevel face with grinder as required
    c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

   a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
   b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
   c. List the polarity that air carbon arc is run on
   d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
   e. Connect air carbon torch arc and compressed air hose to welding machine
   f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
   a. Locate root of weld
   b. Demonstrate control of depth of cut
   c. Demonstrate control of width of cut
   d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
   e. Make gouges of uniform depth
   f. Observe discontinuities as gouging proceeds
   g. Gouge until some weld metal is reached

16. Gouge to Excavate Defect
   a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
   b. Measure to make sure excavation is at proper location and depth
   c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
   d. Clean area of all scale, carbon etc.

17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
   a. Check area for safety
   b. Set SMAW equipment current and polarity for 1/8" E7018
   c. Attach work lead
   d. Preheat and maintain interpass temperature as required
   e. Weld first pass paying special attention to low hydrogen techniques
   f. Grind the weld start and stop to remove cold lap and lack of fusion
   g. Weld the second pass starting from opposite end
   h. Repeat starts and stops until weld is completed
   i. Inspect and submit for non-destructive testing RT or UT

18. Produce Fillet Weld on Sheet Steel T Joints
   a. Check work area for safety
   b. Position steel in a T joint and tack at ends
   c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
   d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
   e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the work place	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work flow by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purposes of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Association alloy classification system for aluminum alloys	M-8 Describe most common weldability problems with aluminum and copper alloys	M-9 [illegible] GMAW [illegible] positions	M-10 Demonstrate aluminum GMAW flat, horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		← Tasks →											
M2 GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3 GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required; understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1 Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2 Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-O9-HO1

Pass a Performance Qualification Test Using GTAW On Carbon Steel in the 6G Position on Pipe

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Set-up welding area and equipment;
B. Set-up work piece and purge gas; and,
C. Weld test piece according to specifications.

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Identify GTAW equipment
D. Identify GTAW welding variables and their effects on weld quality with carbon steel pipe
E. Use GTAW to weld carbon steel in the 6G position on pipe

Student Activities:

A. Set up GTAW equipment
B. Perform welding process prescribed in the 6G position on pipe
C. Perform in process weld inspection
D. Perform in process rework (if required)
E. Perform other weld exercises in the student handbook, as may be assigned by the instructor

WLD-O9-HO2
Pass a Performance Qualification Test Using GTAW On Carbon Steel in the 6G Position on Pipe
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    a. List advantages and disadvantages of GTAW
    b. List five applications where GTAW or PAW are better suited
    c. List give applications which are more suited to SMAW than GTAW
    d. Compare and contrast GTAW and plasma arc welding (PAC)
    e. List by name the parts of a GTAW torch
    f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 2F position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 3F vertical position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"

    e. Fit up and tack a T joint and place in the 4F overhead position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch With 3/32" pointed 2% thoriated tungsten
    d. Cut stainless steel and grind a .30" bevel on edges
    e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

- a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
- b. Cut stainless steel and grind a .30" bevel on edges
- c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
- d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
- e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
   - a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
   - b. Prepare tungsten for given procedure
   - c. Set up GTAW torch for given procedure
   - d. Set current for procedure
   - e. Adjust shielding gas flow rate
   - f. Weld root using free hand technique and using the walking the cup method
   - g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    - a. Use non-low hydrogen electrodes
    - b. Strike arc and hold long arc length 1" away from last weld crater
    - c. Back-up to previous weld crater holding long arc length
    - d. Pre-heat crater with long arc
    - e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    - a. Use low hydrogen electrodes
    - b. Strike arc 1" from crater
    - c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    - d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    - a. List the names and draw side views of the five basic joint configurations
    - b. List the names and draw side views of the variations of grooves
    - c. List the names and draw side views of the T-Joint variations
    - d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    - a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    - b. Clean bevel face with grinder as required
    - c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

    a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
    b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
    c. List the polarity that air carbon arc is run on
    d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
    e. Connect air carbon torch arc and compressed air hose to welding machine
    f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    a. Locate root of weld
    b. Demonstrate control of depth of cut
    c. Demonstrate control of width of cut
    d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    e. Make gouges of uniform depth
    f. Observe discontinuities as gouging proceeds
    g. Gouge until some weld metal is reached

16. Gouge to Excavate Defect
    a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    b. Measure to make sure excavation is at proper location and depth
    c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    d. Clean area of all scale, carbon etc.

17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    a. Check area for safety
    b. Set SMAW equipment current and polarity for 1/8" E7018
    c. Attach work lead
    d. Preheat and maintain interpass temperature as required
    e. Weld first pass paying special attention to low hydrogen techniques
    f. Grind the weld start and stop to remove cold lap and lack of fusion
    g. Weld the second pass starting from opposite end
    h. Repeat starts and stops until weld is completed
    i. Inspect and submit for non-destructive testing RT or UT

18. Produce Fillet Weld on Sheet Steel T Joints
    a. Check work area for safety
    b. Position steel in a T joint and tack at ends
    c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

WLD-O10-HO1

Pass a Performance Qualification Test Using GTAW On Aluminum in the 6G Position on Pipe

Attachment 1: **MASTER** Handout No. 1

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Set-up welding area and equipment;
B. Set-up work piece and purge gas; and,
C. Weld test piece according to specifications.

MODULE OUTLINE:

Instructional Topics:

A. Summary of safety precautions
B. Identify the importance and variations of shielding gas mixtures
C. Select electrode or filler metal, as appropriate
D. Identify GTAW equipment and inspect for safe operations
E. Identify GTAW welding variables and their effects on weld quality with aluminum pipe
F. Use GTAW to weld aluminum in the 6G position on pipe

Student Activities:

A. Set up GTAW equipment
B. Perform welding process prescribed in the 6G position on pipe
C. Perform in process weld inspection
D. Perform in process rework (if required)
E. Perform other exercises in student handbook, as recommended by instructor

WLD-O10-HO2
Pass a Performance Qualification Test Using GTAW On Aluminum in the 6G Position on Pipe
Attachment 2: **MASTER** Handout No. 2

Student laboratory exercises as assigned by Instructor.

GAS TUNGSTEN ARC WELDING (GTAW)

1. Understand Technical Aspects of GTAW
    a. List advantages and disadvantages of GTAW
    b. List five applications where GTAW or PAW are better suited
    c. List give applications which are more suited to SMAW than GTAW
    d. Compare and contrast GTAW and plasma arc welding (PAC)
    e. List by name the parts of a GTAW torch
    f. Describe each control by name and function on the pulsed tig system such as a Lincoln square wave 350 or Miller syncrowave 351 P.
    g. Assemble the GTAW torch, water cooler and GTAW machine
2. Weld Fillet - 2F Horizontal Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 2F position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
3. Weld Fillet - 3F Vertical Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"
    e. Fit up and tack a T joint and place in the 3F vertical position
    f. Weld a .050" fillet weld using .045" ER308-L
    g. Visually inspect joint for burn through, weld size and workmanship
4. Weld Fillet - 4F Overhead Position
    a. Conduct safety inspection of the area and equipment
    b. Weld on 304 stainless steel
    c. Set GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 1/16" pointed 2% thoriated tungsten
    d. Cut stainless steel to .050" X 2" X 10"

   e. Fit up and tack a T joint and place in the 4F overhead position
   f. Weld a .050" fillet weld using .045" ER308-L
   g. Visually inspect joint for burn through, weld size and workmanship

5. Weld on 1/8" Material and 100% Penetration
   a. Conduct safety inspection of the area and equipment
   b. Weld on 304 stainless steel
   c. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   d. Cut stainless steel and grind a .30" bevel on edges
   e. Place two pieces of stainless steel in the backing purge in the 1G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   f. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   g. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.
6. Weld 2G Position Using GTAW
   a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   b. Cut stainless steel and grind a .30" bevel on edges
   c. Place two pieces of stainless steel in the backing purge in the 2G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
7. Weld 3G Position Using GTAW
   a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
   b. Cut stainless steel and grind a .30" bevel on edges
   c. Place two pieces of stainless steel in the backing purge in the 3G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
   d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
   e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver
8. Weld 4G Position Using GTAW

    a. Set up GTAW for high frequency start, direct current electrode negative, 40 amps. Remote current control, assemble GTAW torch. With 3/32" pointed 2% thoriated tungsten
    b. Cut stainless steel and grind a .30" bevel on edges
    c. Place two pieces of stainless steel in the backing purge in the 4G position fixture with a 0" gap. Using 100% Argon as the backing gas at a flow rate of 15 cubic feet per hour
    d. Weld achieving full penetration while adding .062" ER308-L. Make a 2 pass weld
    e. Remove from backing purge and visually inspect for full penetration. No color on welded surfaces except straw is permitted. The back or root of the weld shall be silver.

9. Weld Pipe Open Root Passes All Positions Using GTAW
    a. Fit up and tack weld pipe to within procedure tolerances. (Set up GTAW equipment for welding carbon steel)
    b. Prepare tungsten for given procedure
    c. Set up GTAW torch for given procedure
    d. Set current for procedure
    e. Adjust shielding gas flow rate
    f. Weld root using free hand technique and using the walking the cup method
    g. Apply second pass using weave
10. Produce Welds with Properly Fused Starts and Filled Craters
    a. Use non-low hydrogen electrodes
    b. Strike arc and hold long arc length 1" away from last weld crater
    c. Back-up to previous weld crater holding long arc length
    d. Pre-heat crater with long arc
    e. Shorten arc length, fill crater and continue welding
11. Low Hydrogen Starts and Stops
    a. Use low hydrogen electrodes
    b. Strike arc 1" from crater
    c. Immediately shorten arc length and back up quickly previous weld crater. Holding short arc length
    d. Pause at the crater when it is filled. Continue welding
12. Design Welded Joints
    a. List the names and draw side views of the five basic joint configurations
    b. List the names and draw side views of the variations of grooves
    c. List the names and draw side views of the T-Joint variations
    d. List the name of the type of weld made in each joint
13. Weld V Groove With Backing in Flat Position
    a. Use oxy-fuel equipment to bevel 3/8" steel to 37 1/2°
    b. Clean bevel face with grinder as required
    c. Cut 1/4" material for backing strip
14. Set Up Air Carbon Arc Equipment for Gouging

a. List the minimum rated amperage and duty cycle for a welding machine used for air carbon arc gouging according to lecture
b. List minimum flow rate and pressure for an air compressor used in air carbon arc cutting and gouging
c. List the polarity that air carbon arc is run on
d. Describe approximate amperage settings for 1/8", 3/16", 1/4" and 3/8" carbon electrodes
e. Connect air carbon torch arc and compressed air hose to welding machine
f. Inspect area for safety

15. Use Air Carbon Arc to Excavate a Partial Pen Groove Weld
    a. Locate root of weld
    b. Demonstrate control of depth of cut
    c. Demonstrate control of width of cut
    d. Use air carbon arc cutting equipment to make shallow gouges (about 1/8" deep max.) with stringer technique
    e. Make gouges of uniform depth
    f. Observe discontinuities as gouging proceeds
    g. Gouge until some weld metal is reached
16. Gouge to Excavate Defect
    a. Given the area of suspected discontinuity its size and depth; air carbon 1 gouge using multi pass and stringer gouge to defect depth
    b. Measure to make sure excavation is at proper location and depth
    c. Use air carbon arc equipment. Shape excavation to ensure proper fusion
    d. Clean area of all scale, carbon etc.
17. Make X-Ray Quality Weld Repair on a 2F Position T Joint ½" Plate
    a. Check area for safety
    b. Set SMAW equipment current and polarity for 1/8" E7018
    c. Attach work lead
    d. Preheat and maintain interpass temperature as required
    e. Weld first pass paying special attention to low hydrogen techniques
    f. Grind the weld start and stop to remove cold lap and lack of fusion
    g. Weld the second pass starting from opposite end
    h. Repeat starts and stops until weld is completed
    i. Inspect and submit for non-destructive testing RT or UT
18. Produce Fillet Weld on Sheet Steel T Joints
    a. Check work area for safety
    b. Position steel in a T joint and tack at ends
    c. Place T joint in the 2F position with a spacer on each end so the workpiece is not touching the work bench. This stops any heat sink.
    d. Produce fillet welds equal in size to the thickness of the smallest joint member. With SMAW E6011, E6013 and GMAW and GTAW
    e. Visually inspect to AWS D1.3

19. Produce Fillet Welds on T Joints Made Up of Both Thick and Thin Joint Members Using SMAW
    a. Inspect work area for safety
    b. Set SMAW equipment for type and size of electrode and job requirements
    c. Fit up and tack joint
    d. Weld joint keeping the major portion of heat on thicker section
    e. Clean and visually inspect
20. Use Correct Starts for Low Hydrogen Electrodes
    a. List the AWS steel electrode code last digit designation for low hydrogen electrode
    b. Set up SMAW e.g. and check for safety
    c. Using E7018 strike an arc 1" down the path of welding from where you wish to start
    d. Shorten arc length immediately to low hydrogen arc length
    e. Quickly approximate 3 times as fast as welding travel speed back up the one inch to the point at which the weld should start
    f. Stop movement at starting point and allow weld pool to form
    g. Begin normal travel speed once weld pool reaches required diameter
21. Use Correct Stops for Low Hydrogen Electrodes
    a. Use E7018 to begin weld correctly
    b. Stop increase weld travel speed
    c. Observe weld pool when weld pool size decreases to smallest possible size, break off arc by pulling away
22. Weld Using Large Diameter SMA Electrodes
    a. Set up SMAW equipment for use with 3/16" and E7018
    b. Tack up a T joint using ½" steel
    c. Set amperage from 180 to 200 DC amps
    d. Begin the weld with a low hydrogen start by using a 75° lead angle (To fight arc blow)
    e. Bring lead angle back to normal as the weld progresses 2" along joint
    f. Begin changing the lead angle to a push or forehand angle of 70° to 80° 3" from the end of joint
    g. Make multi-pass fillet welds with smooth contour
    h. Visually inspect to insure

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with coworkers and supervisors						
E Work as a Team	E-1 Understand the roles of coworkers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and [illegible] welds on T and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

3093

Duty P

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on lilfe of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-P1-HO
Identify and Describe the Function of Plasma Arc Cutting (PAC) Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand definitions and description of equipment;
B. Understand the principles of operation; and,
C. Identify equipment and apparatus requirements.

MODULE OUTLINE:

Instructor Topics:

A. PAC power sources
B. The principles involved in PAC equipment operation
C. Process conditions and gas selection
D. Typical PAC conditions for carbon steel and aluminum alloys
E. Identify polarity requirements using PAC on various metals
F. Demonstrate PAC in the flat, horizontal, vertical and overhead positions
G. Identify welding variables and their effects on weld quality

Student Activities:

A. Perform cutting of carbon steel and aluminum in four positions
B. Use oscillating and non-oscillating welding technique

WLD-P2-HO

Identify and Describe the Function of Plasma Arc Welding (PAW) Equipment

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand definitions and description of Plasma Arc Welding equipment;
B. Understand the principles of operation;
C. Identify equipment and apparatus requirements; and,
D. Understand safety factors with the operation and shut-down procedures.

MODULE OUTLINE:

Instructor Topics:

A. Principles involved in the operating of PAW equipment
B. Joint design concepts for PAW
C. Preparation of welding surfaces
D. Prepare butt joints, and tee joints, for welding
E. Demonstrate PAW in positions that are permitted for safe operations
F. Identify polarity requirements using PAW on various metals
G. Identify welding variables and their effects on weld quality

Student Activities:

A. Preheat weld surface
B. Perform welds in positions assigned and supervised by instructor
C. Make adjustments to improve weld quality

WLD-P3-HO

Understand the Safety Factors in Plasma Arc Cutting And Plasma Arc Welding Processes

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Select and use No. 6 filter lens, with side shields, as recommended when welding with transferred arc currents up to 5A; and,

B. When welding with transferred arc currents between 5 and 15A, use a full face light green plastic shield as recommended in addition to eye protection with No. 6 filter.

MODULE OUTLINE:

Instructor Topics:

A. Principles involved in the operating of PAC & PAW equipment
B. Joint design and welding terms
C. Proper application of welding skills for PAC and PAW processes
D. Adequate preparation of welding surfaces
E. Increase knowledge of current industry standards and techniques
F. Demonstrate PAC & PAW in the positions that can be safely used with existing equipment
G. Identify polarity requirements using PAC & PAW on various metals
H. Demonstrate preheat and how to maintain desired temperature
I. Identify welding variables and their effects on weld quality
J. Match PAC & PAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in positions assigned and supervised by instructor
C. Make adjustments to improve weld quality

WLD-P4-HO
Set-Up Plasma Arc Cutting Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify power hook-up requirements;
B. Identify air pressure requirements for Plasma Arc Cutting (PAC) equipment;
C. Perform set-up Plasma Arc Cutting (PAC) equipment in a safe manner; and,
D. Troubleshoot Plasma Arc Cutting (PAC) equipment.

MODULE OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of PAC equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Increase skill level to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Demonstrate PAC in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using PAC on various metals
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match PAC electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in positions assigned and supervised by instructor
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-P5-HO
Set-Up Plasma Arc Welding Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform set-up of Plasma Arc Welding (PAW) equipment in a safe manner;
B. Troubleshoot Plasma Arc Welding (PAW) equipment;
C. Understand terms and definitions of Plasma Arc Welding (PAW) processes;
D. Understand principles of operation of manual Plasma Arc Welding (PAW) [per AWS Recommended Policies for Plasma Arc Welding C5.1-73;3.2]; and,
E. Understand equipment and apparatus requirements (per AWS C5.1-73;4.1).

MODULE OUTLINE:

Instructor Topics:

A. Emphasizes the principles involved in the operating of PAW equipment
B. Demonstrate knowledge of joint design and welding terms
C. Demonstrate ability to interpret drawings and blueprints
D. Demonstrate knowledge of the proper application of welding skills
E. Demonstrate knowledge of adequate preparation of welding surfaces
F. Increase skill level to pass certification tests offered by an employer
G. Prepare butt joints, and tee joints, for welding
H. Increase knowledge of current industry standards and techniques
I. Demonstrate PAW in the flat, horizontal, vertical and overhead positions
J. Identify polarity requirements using PAW on various metals
K. Demonstrate preheat and how to maintain desired temperature
L. Identify welding variables and their effects on weld quality
M. Identify the AISI steel classification system
N. Match PAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in positions approved and supervised by instructor
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-P6-HO
Perform Plasma Arc Cutting and Plasma Arc Welding on Various Materials
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Gouge ferrous and non-ferrous metals according to industry standards;
B. Cut various angles on ferrous and non-ferrous metals; and,
C. Weld ferrous and non-ferrous metals according to industry standards using Plasma Arc Welding (PAW) equipment.

MODULE OUTLINE:

Instructor Topics:

A. Principles involved in the operating of PAC & PAW equipment
B. Knowledge of joint design and welding terms
C. Interpret drawings and blueprints for PAC and PAW applications
D. Proper application of welding skills
E. Preparation of welding surfaces
F. Description of skill levels needed to pass certification tests offered by an employer
G. Prepare joints for welding
H. Demonstrate PAC & PAW in the flat, horizontal, vertical and overhead positions
I. Identify polarity requirements using PAC & PAW on various metals
J. Demonstrate preheat and how to maintain desired temperature
K. Identify welding variables and their effects on weld quality
L. Identify the AISI steel classification system
M. Match PAC & PAW electrodes to an appropriate base metal

Student Activities:

A. Preheat weld surface
B. Perform welds in four positions, or as approved by instructor for safe conditions
C. Use oscillating and non-oscillating welding technique
D. Perform single pass and multi-pass welds
E. Make adjustments to improve weld quality

WLD-P7-HO
Perform Shut Down Procedures on Plasma Arc Cutting And Plasma Arc Welding Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand shut-down procedures on Plasma Arc Cutting (PAC) and Plasma Arc Welding (PAW) equipment;
B. Perform air and gas shut-down procedures; and,
C. Perform clean-up of work area.

MODULE OUTLINE:

Instructor Topics:

A. Principles involved in the operating of PAC & PAW equipment
B. Gouging and cutting of ferrous and non-ferrous metals
C. Joint preparation and cleaning of surfaces for welding
D. Shut down sequence for PAC and PAW processes

Student Activities:

A. Perform shut down operation for PAC and PAW
B. Inspect equipment
C. Clean weld surface
D. Clean workplace and equipment

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	← Tasks →												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use [illegible] statistics, [illegible], and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe aluminum [illegible] classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW fillet and GMAW [illegible] and butt joints on various metals in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties ← **Tasks** →

M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required; understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-Q1-HO
Check Weld Size
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify weld specification;
B. Identify weld gages and their use;
C. Identify the symbol for weld size (specification); and,
D. Identify common causes of discontinuities related to shape, size and contour.

MODULE OUTLINE:

Instructor Topics:

A. Welding size variation and specification
B. Illustrate visual inspection
C. Identify welding variables relevant to the prevention of specific weld imperfections
D. How to gage weld size
E. How to follow a welding procedure specification (WPS)
F. When to apply multi-pass welds
G. When to apply weaving technique
H. How to determine speed of travel

Student Activities:

A. Increased knowledge and skill of weld inspection by demonstration
B. Determine weld quality for acceptability to a code or standard
C. Determine defects in weld quality
D. Perform dye penetration test

WLD-Q2-HO
Perform Visual Inspection
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify and define weld discontinuities and defects;
B. Identify the Welding Inspectors responsibilities relating to discontinue and defects;
C. Identify the common causes of discontinuities related to shape, size and contour;
D. Identify the common causes of discontinuities related to internal inconsistencies and weld metal irregularities; and,
E. Identify the common causes of discontinuities related to weld and base metal properties.

MODULE OUTLINE:

Instructor Topics:

A. Welding size variation and specification
B. Visual inspection methods
C. Welding variables that can be controlled to prevent specific weld imperfections
D. How to gage weld size
E. Include nondestructive and destructive testing techniques
F. How to follow a Welding Procedure Specification (WPS)
G. Selection of samples for tests
H. Proof and leak tests
I. How to inspect for welding defects: cracks, cavities, solid inclusions, incomplete fusion, defects in weld shape and contour, arc strikes, and excessive spatter
J. Non-destructive evaluations: dye-penetrant, florescent penetrant, magnetic particle, ultrasonic, and radiographic
K. Destructive evaluations: mechanical (tensile and sheer), metallurgical (specimen for photomicrographs of metallic structure, defects, etc.)

Student Activities:

A. Determine weld quality for acceptability to a code or standard
B. Determine defects in weld quality
C. Perform destructive and non-destructive testing

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

← Tasks →

Duties													
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal designation system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW [illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

3110

3111

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-R1-HO
Remove Weld Defect and Prepare for Re-Weld
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify weld defects;
B. Understand surface preparation; and,
C. Perform remodel of weld discontinuities.

MODULE OUTLINE:

Instructional Topic:

A. Describe the most common welding problems for various welding processes
B. Perform visual inspection
C. Prepare geometry for reweld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size

Student Activities:

A. Remove weld defect
B. Prepare weld surface for re-weld
C. Check weld size using gages
D. Re-weld workpiece

WLD-R2-HO
Verify Defect Removal
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Identify weld defects; and,
B. Remove weld defects.

MODULE OUTLINE:

Instructional Topic:

A. Describe the most common welding problems for various welding processes
B. Perform visual inspection
C. Prepare geometry for re-weld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size

Student Activities:

A. Remove weld defect
B. Prepare weld surface for reweld
C. Check weld size using gages
D. Re-weld workpiece

WLD-R3-HO
Pre-Heat Weld (If Required)
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand pre-heating procedures and requirements; and,
B. Understand post-heating requirement procedures.

MODULE OUTLINE:

Instructional Topic:

A. Rationale for pre-heating and post-heating
B. Perform visual inspection
C. Prepare geometry for re-weld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size
K. Post-heat, if specified

Student Activities:

A. Practice pre-heat
B. Practice post-heat

WLD-R4-HO
Perform Re-Weld
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform pre-heat;
B. Understand weld requirements; and,
C. Perform reweld as required.

MODULE OUTLINE:

Instructional Topic:

A. Describe the most common welding problems for various welding processes
B. Perform visual inspection
C. Prepare geometry for re-weld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size

Student Activities:

A. Remove weld defect
B. Prepare weld surface for re-weld
C. Check weld size using gages
D. Re-weld workpiece

WLD-R5-HO
Repeat In-Process Inspection
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Perform in-process rework;
B. Inspect weld after repair; and,
C. Understand weld requirements.

MODULE OUTLINE:

Instructional Topic:

A. Perform visual inspection
B. Testing of welds
C. Prepare geometry for re-weld
D. Verify defect removal
E. Identify welding variables and their effects on weld quality
F. Make adjustments to welding equipment and welding techniques to improve weld quality
G. Preheat weld (if required)
H. Re-weld and repair area
I. Repeat in-process inspection
J. Check weld size

Student Activities:

A. Remove weld defect
B. Prepare weld surface for re-weld
C. Check weld size using gages
D. Re-weld workpiece

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties	Tasks												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with coworkers and supervisors						
E Work as a Team	E-1 Understand the roles of coworkers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for practice layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Troubleshoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum [illegible] metal [illegible] system for aluminum alloys	M-8 Describe most common weldability problems [illegible] with aluminum and copper alloys	M-9 [illegible]	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

Duty S

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		Tasks												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-S1-HO
Return Unused Consumables
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Place unused materials in their assigned locations for future use; and,
B. Understand the rationale for tracking programmed materials for specific jobs.

MODULE OUTLINE:

Instructional Topics:
A. Principles of economy in the use of materials
B. Assigned locations materials located for specific jobs
C. Assigned locations for consumables
D. Tracking costs of misplaced or lost materials

Student Activities:
A. Exercises assigned by instructor to recommend location for materials and consumables
B. Estimating costs of misplaced or lost materials

WLD-S2-HO
Store Tools
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Place tools in their assigned location; and,
B. Maintain tools in a safe condition in an available status.

MODULE OUTLINE:

Instructional Topics:

A. The significance of tools to the professional
B. How to maintain welders tools and equipment
C. How to secure welders tools and equipment
D. How to inspect the tools for operability

Student Activities:

A. Assigns locations and layout of tools
B. Practical exercise in mandatory tools

WLD-S3-HO
Secure Welding Equipment
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
A. Shut down equipment; and,
B. Secure equipment in a safe, stable, and non-operational state.

MODULE OUTLINE:

Instructional Topics:
A. Essential shut down operations (specifics are covered in other modules)
B. Equipment to be left in stable, non-hazardous state
C. Equipment to be located in safe location
D. Final inspection of equipment to preclude future loss and insure operability

Student Activities:
A. Recommended locations for all equipment
B. Inspect shop by OSHA Rules

WLD-S4-HO
Secure Welding Gases
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:
- A. Secure welding gases in a safe condition; and,
- B. Shut down gas operations in an approved manner.

MODULE OUTLINE:

Instructional Topics:
- A. How to identify damage to compressed gas cylinders, valves, hoses, gages, and regulators.
- B. Indications of leaks and corrosion
- C. Contaminated valves
- D. Flammable and non-flammable hazards of compressed gases used in welding process
- E. Securing of lines and regulators
- F. Proper storing of all gases and liquids

Student Activities:
- A. Practice securing equipment
- B. Practice storing or locating equipment in proper location

WLD-S5-HO
Clean Work Area(s)
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Clean work area(s);
B. Use approved cleaning methods for welding equipment; and,
C. Perform final inspection of work area(s).

MODULE OUTLINE:

Instructional Topics:

A. How to clean a welding shop operation
B. Use or non-use of compressed air
C. Use of approved cleaning materials
D. Segregation of gases and equipment in approved areas
E. General layout for efficiency
F. Knowledge of hazardous chemicals

Student Activities:

A. Recommend cleaning materials
B. Recommend cleaning methods
C. Have "wall to wall" cleaning activity

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

	Duties	Tasks												
A	Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B	Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C	Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D	Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E	Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F	Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G	Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H	Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
		H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I	Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J	Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K	Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1	Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2	Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1	Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW [illegible] and GMAW [illegible] in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		← Tasks →												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 50 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-T1-HO
Display a General Understanding of Emergency Vehicle Terminology
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the technologies and scope of company products; and,
B. Understand company systems and manufacturing processes.

PRESENTATION OUTLINE:

1. Company products and customer base
2. Company goals, employee goals, and quality plan
3. Company organization and support systems
4. Company production processes and technologies
5. Production work flow and job relationships
6. Company's competitive position in world market
7. Individual employee roles and contributions to company success
8. Future growth potential for individual and company goals or services

WLD-T2-HO
Understand the Functions of Equipment Being Assembled
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the general production processes; and,

B. Understand specific equipment, major assemblies, and sub-assemblies.

MODULE OUTLINE:

1. Purpose of major assemblies and sub-assemblies in product use, operation, and functionality
2. Potential for improvement in work flow or use of tools
3. Work team interactions and responsibilities
4. Team problem-solving and continuous improvement

WLD-T3-HO

Understand How Components Relate as a Total System

Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the company's systems and subsystems; and,

B. Understand the importance of functional areas such as marketing, product design, purchasing, production planning, etc.

MODULE OUTLINE:

1. The company organization
2. Functional staff and support activities
3. Systems and sub-systems
4. Computer information applications and their use
5. Design and documentation
6. Production planning (job orders and raw materials)
7. Financial and inventory/assets
8. Quality systems, corrective action reports, and continuous improvement
9. Marketing, warranty, and customer satisfaction
10. Human resources and employee programs
11. Safety and occupational health/wellness

WELDER **... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.**

Duties	← Tasks →												
A Follow Safety Practices	A-1 Demonstrate understanding of safety rules	A-2 Assume personal safety standards for self and others	A-3 Describe the purpose and use of protective equipment	A-4 Demonstrate proper handling of hazardous materials	A-5 Demonstrate knowledge of first aid and CPR	A-6 Practice safety precautions when using tools	A-7 Demonstrate proper wearing and use of safety equipment	A-8 Create and maintain a safe work station	A-9 Demonstrate safety precautions regarding ARC flash	A-10 Demonstrate eye safety precautions	A-11 Perform grinding and brushing technique safety	A-12 Maintain adequate ventilation	A-13 Mark "hot-work"
B Total Quality	B-1 Apply principles and tools of continuous quality improvement	B-2 Understand the importance of quality in the manufacturing process	B-3 Implement concepts of quality in the workplace	B-4 Follow the Quality Plan and recommend improvements in work methods or tooling	B-5 Establish methods, plans, and procedures to maintain quality								
C Work Ethics	C-1 Be prompt and on the job in accordance with work schedule	C-2 Value honest work ethics, dedication, and responsibility in the workplace	C-3 Demonstrate high moral values	C-4 Display a neat and clean workplace	C-5 Practice careful use and maintenance of tools and equipment	C-6 Be committed to excellence and quality	C-7 Present a good company image in attire and attitude	C-8 Support a positive work environment	C-9 Practice a positive attitude				
D Communication Skills	D-1 Practice being a good listener	D-2 Demonstrate good reading, comprehension and writing skills	D-3 Document manufacturing processes	D-4 Prepare a recommendation for continuous improvement	D-5 Prepare a summarized priority list of work responsibilities	D-6 Display ability to follow directions, give directions and accept constructive criticism	D-7 Demonstrate positive communication skills with co-workers and supervisors						
E Work as a Team	E-1 Understand the roles of co-workers	E-2 Respect peer relationships	E-3 Share resources to accomplish necessary tasks	E-4 Facilitate the work ethic by completing tasks on time and accurately	E-5 Be involved with problem solving	E-6 Apply creative thinking	E-7 Support a positive attitude	E-8 Encourage good feelings and morale	E-9 Understand purpose and goals of the organization	E-10 Plan and organize work as a team	E-11 Be willing to lead in areas of knowledge and expertise	E-12 Demonstrate willingness to learn new methods and skills	E-13 Demonstrate good personal relations skills
F Mathematical Skills	F-1 Exhibit understanding of basic arithmetic functions	F-2 Exhibit understanding of converting fractions and decimals	F-3 Demonstrate practical mathematics in the use of measurement tools	F-4 Inter-convert Metric/English measurements	F-5 Perform practical mathematical applications relevant to area of work	F-6 Use applied statistics, graphs, and charts for purpose of analysis and problem solving							
G Weld-Related Requirements	G-1 Read job method plan	G-2 Verify and upgrade paperwork	G-3 Interpret drawings and blueprints	G-4 Read welding specifications and procedures									
H Blueprinting, Structural Layout and Fit-Up	H-1 Understand parts of blueprint	H-2 Describe alphabet of lines	H-3 Demonstrate tape reading and measurement techniques	H-4 Use framing square to square parts	H-5 Use level and other devices to verify layout	H-6 Understand and interpret shop drawings for precise layout	H-7 Demonstrate knowledge of welding symbols	H-8 Identify various structural shapes and their respective parts	H-9 Identify structural components and support frameworks of buildings and their components	H-10 Describe proper placement of stiffeners and supports when modifying existing structures	H-11 Identify fillet weld sizes for various thicknesses of base metals	H-12 Describe proper sequence when cutting various shapes to structural drawing specs	H-13 Describe methods for layout slopes and rolling tolerances
	H-14 Describe the use of jigs and fixtures in layout and fit-up	H-15 List the steps to be followed when planning a job	H-16 Interpret structural detail sheets	H-17 Describe methods for straightening and removing damaged structural and machinery parts									
I Set-Up Welding Process(es)	I-1 Gather materials for the job	I-2 Gather welding equipment and tools	I-3 Check welding equipment for safety	I-4 Set-up equipment	I-5 Make test-weld to verify parameters								
J Prepare Joint for Welding	J-1 Prepare joint geometry using mechanical method	J-2 Clean weld area	J-3 Fit-up joint	J-4 Verify joint preparation									
K Oxyacetylene Cutting and Welding	K-1 Identify and describe the function of each piece of equipment	K-2 Identify the safety hazards	K-3 Describe preventive and/or protective measures	K-4 List the welding variables and describe their effects on weld quality	K-5 Describe the AWS oxyfuel gas welding rod classification system	K-6 Describe techniques for preventing or reducing welding related distortion	K-7 Weld mild steel sheet metal using techniques that will minimize the effects of distortion	K-8 List the variables associated with cutting	K-9 Cut mild steel plate in a safe manner				
L1 Shielded Metal Arc Welding (SMAW) (Basic)	L-1 Preheat joint	L-2 Initiate welding process	L-3 Perform weld sequence	L-4 Control weld technique	L-5 Maintain preheat and perform interpass	L-6 Use the carbon arc process to cut and gouge base weld materials	L-7 Apply welders identification	L-8 Control post-weld temperature according to procedures	L-9 Post clean weld	L-10 Post finish weld			
L2 Shielded Metal Arc Welding (SMAW) (Advanced)	L-11 Pass a performance qualification test using SMAW on carbon steel in the 6G position	L-12 Pass a performance qualification test using SMAW on stainless steel pipe in the 6G position											
M1 Gas Metal Arc Welding (GMAW) (Basic)	M-1 Identify GMAW equipment	M-2 Identify the safety hazards	M-3 Describe the preventive and protective measures	M-4 Identify welding variables and their effects upon weld quality	M-5 Trouble-shoot equipment	M-6 Describe AWS electrode classification system	M-7 Describe Aluminum Assoc. metal classification system for aluminum alloys	M-8 Describe most common weldability problems associated with aluminum and copper alloys	M-9 [illegible] GMAW [illegible] and [illegible] on various [illegible] in various positions	M-10 Demonstrate aluminum GMAW flat horizontal, vertical and overhead	M-11 Describe GMAW filler wires	M-12 Demonstrate ability to repair welds	

WELDER ... that person who is responsible for the planning, layout, fit up of materials, and operation of welding equipment to prepare the work and perform welding operations necessary to produce a work piece to prescribed engineering standards.

Duties		← Tasks →												
M2	GMAW Short Circuit Transfer (Intermediate)	M-13 Demonstrate machine adjustments (voltage, amps, wire speed)	M-14 Initiate welding process	M-15 Perform weld sequence	M-16 Control weld technique	M-17 Understand welding characteristics of various shielding gases	M-18 Post-clean weld	M-19 Perform interpass preparation	M-20 Demonstrate short circuit GMAW flat horizontal, vertical and overhead	M-21 Post finish weld	M-22 Describe GMAW filler wires	M-23 Describe basic weld discontinuities		
M3	GMAW Spray and Pulsed Spray, Pipe Transfer (Advanced)	M-24 Demonstrate pre-weld cleaning	M-25 Demonstrate interpass cleaning	M-26 Demonstrate adjustment to pulse and spray transfer machines	M-27 Demonstrate GMAW in flat, horizontal, vertical and overhead positions	M-28 Pre-heat joint, if required, understand joint preparation	M-29 Initiate welding process	M-30 Perform weld sequence	M-31 Describe AISI stainless steels classification system	M-32 Describe weldability problems associated with straight chromium, nickel and stainless steel	M-33 Describe detrimental effects of vibration on the life of piping systems	M-34 Describe methods of minimizing detrimental effects of pressure and heat on life of pipe systems	M-35 Pass a performance qualification test using GMAW on pipe in the 6G position	
N	Flux Core Arc Welding (FCAW)	N-1 Understand the safety factors using FCAW equipment	N-2 Troubleshoot FCAW equipment	N-3 Perform weld sequence	N-4 Shut down FCAW equipment									
O1	Gas Tungsten Arc Welding (GTAW) (Basic)	O-1 Identify GTAW equipment	O-2 Identify the safety standards	O-3 Describe the preventive and protective measures	O-4 Identify the welding variables and their effects upon weld quality	O-5 Troubleshoot equipment	O-6 Describe AWS electrode classification system	O-7 Describe AWS filler metal classification system	O-8 Perform GTAW fillet and groove welds on T and butt joints on various metals in various positions					
O2	Gas Tungsten Arc Welding (GTAW) (Advanced)	O-9 Pass a performance qualification test using GTAW on carbon steel in the 6G position on pipe	O-10 Pass a performance qualification test using GTAW on aluminum in the 6G position on pipe											
P	Plasma Arc Cutting and Welding	P-1 Identify and describe the function of Plasma Arc Cutting (PAC) equipment	P-2 Identify and describe the function of Plasma Arc Welding (PAW) equipment	P-3 Understand the safety factors in Plasma Arc Cutting and Plasma Arc Welding processes	P-4 Set-up Plasma Arc Cutting equipment	P-5 Set-up Plasma Arc Welding equipment	P-6 Perform Plasma Arc Cutting and Plasma Arc Welding on various materials	P-7 Perform shut down procedures on Plasma Arc Cutting and Plasma Arc Welding equipment						
Q	In-Process Weld Inspection	Q-1 Check weld size	Q-2 Perform visual inspection											
R	In-Process Rework	R-1 Remove weld defect and prepare for reweld	R-2 Verify defect removal	R-3 Pre-heat weld (if required)	R-4 Perform reweld	R-5 Repeat in-process inspection								
S	Housekeeping Activities	S-1 Return unused consumables	S-2 Store tools	S-3 Secure welding equipment	S-4 Secure welding gases	S-5 Clean work area(s)								
T	Emergency Vehicle Terminology	T-1 Display a general understanding of emergency vehicle terminology	T-2 Understand the functions of equipment being assembled	T-3 Understand how components relate as a total system										
U	Wellness/Physical Abilities	U-1 Demonstrate ability to lift 60 pounds	U-2 Demonstrate ability to tolerate heights up to 100 feet	U-3 Ability to work from various positions while standing on concrete for extended periods	U-4 Display ability to work in hot/cold environment for 8-10 hours	U-5 Present a history of documented regular attendance at work	U-6 Apply wellness information to lifestyle to maintain health							

WLD-U1-HO
Demonstrate Ability to Lift 50 Pounds
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the methods and physics involved in lifting;
B. Understand the mechanisms and limitations of lifting;
C. Be able to lift products safely in accordance with safe methods and physical limitations; and,
D. Use lift trucks and other lift-assist equipment in a safe manner.

MODULE OUTLINE:

1. Safety and industrial health statistics for back and muscular injuries from improper lifting techniques
2. Approved methods for safe lifting within the job description
3. Use of lift assist devices on the job
4. Need for individual assessment with full consideration for physical limitation and any prior injuries
5. Procedure for physical examination by company or private physician
6. Minimizing risk for company and the individual
7. Procedure for reporting personal injuries on the job

WLD-U2-HO
Demonstrate Ability to Tolerate Heights up to 100 Feet
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand capability to tolerate and adjust to safe working conditions from Heights; and,

B. Understand safe working conditions above ground level.

MODULE OUTLINE:

1. Types of work encountered at heights
2. Methods of securing individual and equipment
3. Methods of controlling movement
4. Backup and fail-safe systems
5. Methods of tolerating heights
6. Realistic assessment of capabilities and risks
7. Following OSHA and company approved procedures

WLD-U3-HO
Ability to Work from Various Positions While Standing on Concrete for Extended Periods
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the various positions the welder assumes while standing, and,
B. Understand the reasons for wearing personal protective equipment.

PRESENTATION OUTLINE:

1. Methods of working from the standing position
2. Approved variations of the standing position
3. Placement of fixtures, tools, and gas bottles
4. Movement of welding apparatus or machine
5. Wearing the proper shoes is important to comfort as well as safety
6. Relaxation techniques to use during break periods
7. Working with a planned approach that reduces stress
8. Walking relaxes body tension

WLD-U4-HO
Display Ability to Work in Hot/Cold Environment for 8-10 Hours
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the risks of working in hot/cold environment for extended periods; and,

B. Understand the need to wear protective equipment, and take appropriate measures to protect against heat-stroke or frost-bite in extreme temperatures.

MODULE OUTLINE:

1. The body's reaction to hot temperatures and radiation from the sun
2. Degree of bodily injury from heatstroke/sunstroke, sunburn,
3. Preventive measures, protective clothing and first aid
4. The body's reaction to cold temperatures, frost-bite, and wind chill
5. Degrees of injury from cold temperatures and wind chill
6. Preventive measures, protective clothing, and first-aid
7. Medical follow-up following exposure

WLD-U5-HO
Present a History of Documented Regular Attendance at Work
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to:

A. Understand the need for prompt reporting to work; and,
B. Take pride in the professional responsibility displayed by a regular attendance schedule.

PRESENTATION OUTLINE:

1. The worker's reputation of starting on time is one of reliability, delivery of work as promised, and ability to work as a team
2. Starting at the scheduled time may also be a reflection of dedication, lifestyle, and good health
3. Workers that are consistently late usually have a series of problems that need to be identified individually - if not addressed promptly, the worker may be released
4. If a lesser skilled supervisor or entry level worker has to fill in for a highly skilled worker, possible results are poor quality, accidents, machine maintenance problems, interruptions, and equipment down time

WLD-U6-HO
Apply Wellness Information to Lifestyle to Maintain Health
Attachment 1: **MASTER** Handout

OBJECTIVE(S):

Upon completion of this unit the student will be able to assess personal health and fitness levels by evaluation in lifestyles, fitness components, stress management, nutrition and weight control.

MODULE OUTLINE:

1. Life scan profile
2. Heart factors and cardiovascular endurance
3. Cholesterol and blood sugar
4. Pulmonary assessment
5. Muscular and skeletal flexibility assessment
6. Muscular strength
7. Nutritional analysis